SCIENTIFIC AMERICAN
No. 332 SUPPLEMENT

Scientific American Supplement. Vol. XIII. No. 332. Scientific American, established 1845.

NEW YORK, MAY 13, 1882.

Scientific American Supplement, $5 a year. Scientific American and Supplement $7 a year.

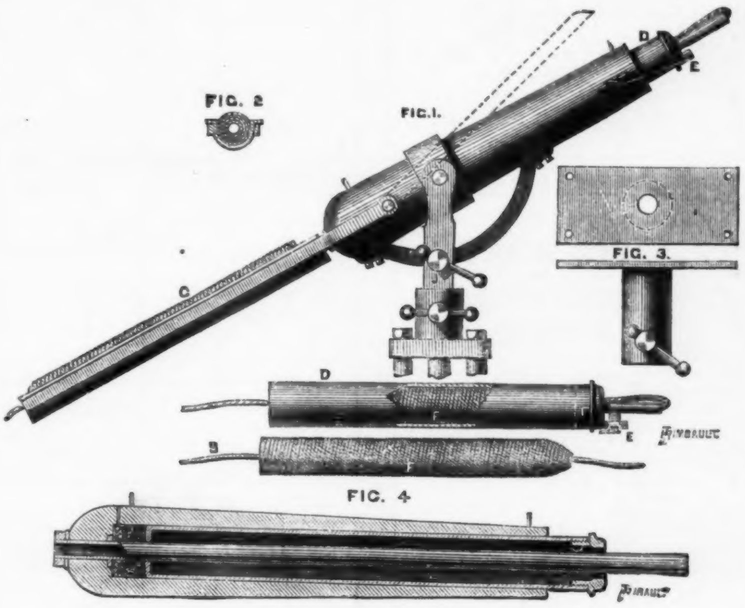
NAVAL AND SUBMARINE EXHIBITION, LONDON.

On the 10th April, the Naval and Submarine Exhibition opened at Agricultural Hall, London. The display was very interesting, embracing life-saving devices, steering gear, pile driving, dock building, and every conceivable appliance or mechanism used on shipboard or in connection with water structures of any kind. We present herewith a few illustrations selected from among the exhibits.

GUN FOR CARRYING LIFE ROPE.

Messrs. Evans & Low show their life-line gun, with which some very satisfactory trials were made the other day. As will be seen from the section, Fig. 2, a tube passes up through the axis of the gun, projecting some distance from the muzzle, and extended so as to form an opening through the breech. The projectile consists of a steel cylinder longer than the bore of the gun, but not so long as the central tube passing through the bore, as just described. The forward end of this projectile or cylindrical case is closed with a cap fastened by a bayonet joint, and it contains a cop, carrying about 350 yards of line. A hole is made in the axis of this cop large enough to allow the central tube to pass through it, and when the gun has been loaded (an annular cartridge is used), the cord is led from the forward end of the cop in the projectile, down the central tube, and out through the breech of the gun. On the front of the projectile case is a small bracket for carrying a signal rocket; when the projectile leaves the gun the pull on the cord attached to the bracket and the outside of the gun, as shown, ignites the composition and fires the signal. Connected to the gun by levers jointed to the trunnions is a trough in which is placed a second or third cop if desired, so that when the line in the projectile is run out, that in the second cop is drawn upon. In this way 350 yards of line have been fired from a gun 2 feet long, 2·5 inches diameter, and with two ounces of powder. The general view of the gun, Fig. 1, shows it mounted on a tripod, a convenient way when firing from the shore at a ship; but the great advantage of this gun is that it is adapted thoroughly for firing from the ship on the shore, thus removing all the uncertainty and loss of time, inseparable from firing, often in the night, at a stranded vessel. As supplied, this gun is provided with six sockets, of the form shown in Fig. 3, which are mounted on the gunwale of the ship, in such a way that the gun can be fired at the shore, no matter what the position of the ship may be.

The construction of the gun is so simple, and the method of manipulation so evident, that no further description is necessary, but we may add the following data: The weight of the cop in the projectile is $2\frac{1}{2}$ lb., the thickness of line $\frac{3}{16}$ in.



EVANS & LOW'S LIFE LINE GUN.

Engineering says: "Experiments show that the ranges to be obtained with different charges were as follows:

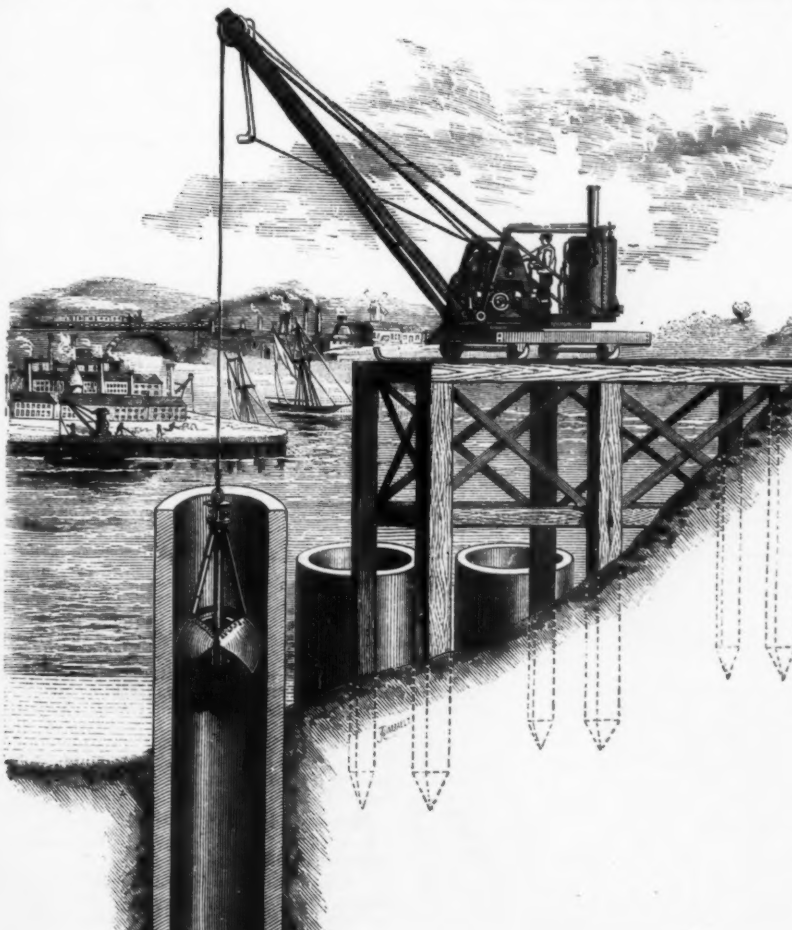
Ounces.		Yards.
$1\frac{1}{2}$	powder charge will give a range of	275 to 300
2	" " "	350 to 375
$2\frac{1}{2}$	" " "	425 to 450
3	" " "	475 to 500
$3\frac{1}{2}$	" " "	575 to 600

EXCAVATING APPARATUS.

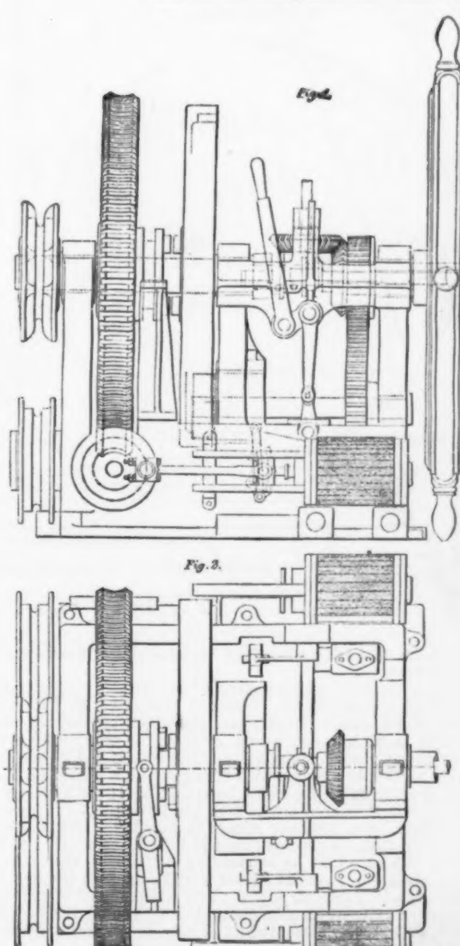
Messrs. Bruce & Batho make an admirable display of models of dredging and excavating plant. Their exhibits include a Bruce's crane and excavator, in which the excavator is worked by two chains or ropes, an excavator arranged to be worked by a single rope or chain, and models of the same, as well as a model of the crane and excavator to illustrate its working. These cranes may be used for excavating purposes when fitted to a barge, or for sinking wells, bridge foundations, piers, and quay walls, as shown.

STEAM STEERING APPARATUS.

Steam steering apparatus forms an important section of the exhibits at the Naval and Submarine Exhibition. Of these we may describe that exhibited by Messrs. J. H. Wilson & Co., of Liverpool, of which we give engravings. This gear is made for either steam power alone, or for being worked either by steam or hand at pleasure, and it is this latter arrangement that we illustrate. It consists, as will be seen, of a pair of small horizontal engines fixed on opposite sides of the baseplate, the connecting rods of these engines being coupled to cranks at right angles, situated at the opposite ends of a shaft carrying a worm, and this worm gearing into a large wormwheel, as shown. The wormwheel, just named, is mounted on the main shaft which carries the chainwheel, operating on the chains which are led off to the tiller. The large wormwheel is not keyed on the shaft which carries it, but is connected to it by the clutch shown, this clutch being provided with a hand



BRUCE & BATHO'S EXCAVATING APPARATUS.



STEAM STEERING GEAR—WILSON & CO.

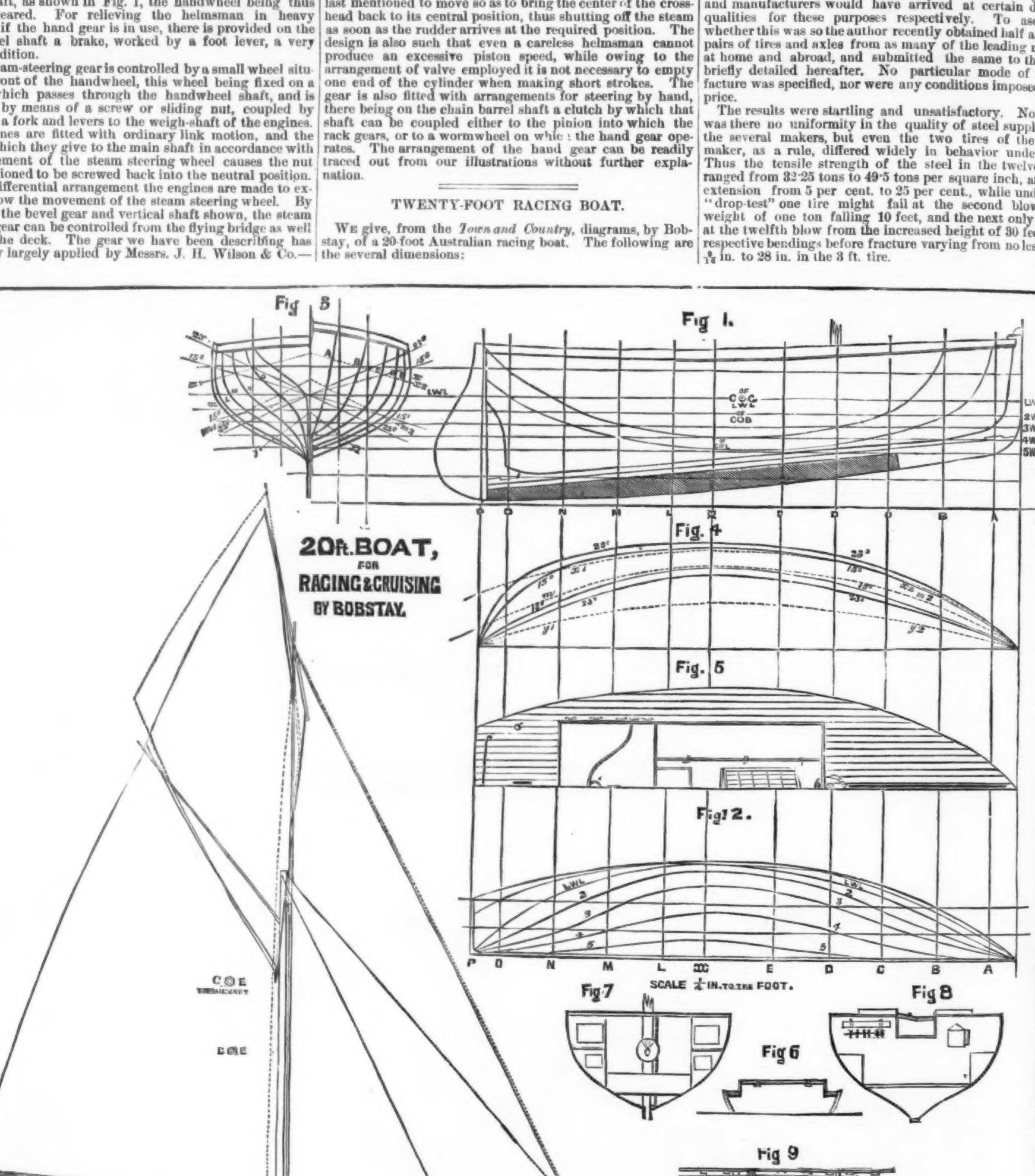
lever, so that it can be readily thrown out of gear with the wormwheel, and made to engage (on its opposite side) with a large internal spurwheel, also mounted on the same shaft. Gearing into the large internal spurwheel is a pinion, fixed on the same short shaft as an external spurwheel, this latter wheel being, in its turn, geared into by a pinion on the handwheel shaft, as shown in Fig. 1, the handwheel being thus double geared. For relieving the helmsman in heavy weather, if the hand gear is in use, there is provided on the handwheel shaft a brake, worked by a foot lever, a very useful addition.

The steam-steering gear is controlled by a small wheel situated in front of the handwheel, this wheel being fixed on a spindle which passes through the handwheel shaft, and is operated by means of a screw or sliding nut, coupled by means of a fork and levers to the weigh-shaft of the engines. The engines are fitted with ordinary link motion, and the motion which they give to the main shaft in accordance with the movement of the steam steering wheel causes the nut just mentioned to be screwed back into the neutral position. By this differential arrangement the engines are made to exactly follow the movement of the steam steering wheel. By means of the bevel gear and vertical shaft shown, the steam steering gear can be controlled from the flying bridge as well as from the deck. The gear we have been describing has been very largely applied by Messrs. J. H. Wilson & Co.—we believe to nearly a hundred vessels—and it has proved very successful.

Another steam steering gear which we are able to illustrate this week is that of Mr. Charles R. Simey, of 55 Fawcett Street, Sunderland. In this gear (of which engravings are on first page) but one steam cylinder is used, this cylinder being placed transversely to the vessel, and its piston giving motion to a rack which engages with a pinion on the main shaft carrying the chain barrel. This latter is of large size, so that if desired a wire rope can be employed in place of a chain, thus securing silence in working. It will also be noticed that the rope or chain is led off from the under side of the barrel, so as to reduce the "nip" which takes place when the direction of the lead is changed through a large angle in a limited space. The admission of steam to the steam cylinder can be controlled by a small handle (or tiller), or by a small handwheel as may be preferred by the purchasers, and the movement given to the valve by hand is corrected by the movement of the piston, so that the latter follows the movement of the hand lever, the differential gear being neatly and simply carried out. It will be seen that just at the back of the main framing are two levers connected with a crosshead pushing on a slide rod. One of the levers just mentioned is fixed upon an upright shaft which is moved by hand and opens the slide valve by moving one end of the crosshead, while the other lever is fixed on a hollow spindle which carries a wormwheel worked by a worm on the barrel shaft, the revolution of which causes the lever last mentioned to move so as to bring the center of the crosshead back to its central position, thus shutting off the steam as soon as the rudder arrives at the required position. The design is also such that even a careless helmsman cannot produce an excessive piston speed, while owing to the arrangement of valve employed it is not necessary to empty one end of the cylinder when making short strokes. The gear is also fitted with arrangements for steering by hand, there being on the chain barrel shaft a clutch by which that shaft can be coupled either to the pinion into which the rack gears, or to a wormwheel on whic : the hand gear operates. The arrangement of the hand gear can be readily traced out from our illustrations without further explanation.

TWENTY-FOOT RACING BOAT.

We give, from the *Town and Country*, diagrams, by Bobstay, of a 20-foot Australian racing boat. The following are the several dimensions:



TWENTY-FOOT BOAT FOR RACING AND CRUISING. BY BOBSTAY.

Length	20 ft.
Beam, extreme	7 ft.
Draught, aft	3 ft. 9 in.
Draught 1 foot aft of stem	2 ft.
Area of L. W. plane	93·38 s. ft.
Displacement in tons	3·3
Do. per inch at L. W. L.	4·4 cwt.
Midship section aft of center of length of L.W.L.	11·5 ft.
Center of buoyancy, do.	10·44 ft.
Lateral resistance, do.	11·2 ft.
Effort of lower sail, do	10·2 ft.
Buoyancy below L.W.L.	0·67 ft.
Ballast inside	1 ton 4 cwt.
Ballast on keel	1·01 ton.
Total ballast	2 tons 4 cwt.
Y. R. A. tonnage	3 46·94 tons.
Area of lower sail	495·4 s. ft.

Gastric Digestion.—The author has discovered in certain ferments of caseine, a diastase capable of transforming this substance into a peptone, similar to those met with in the digestive canal.—*H. Duclaux.*

STEEL FOR TIRES AND AXLES.*

By Benjamin Baker, M. Inst. C. E.

The present experience with reference to the use of steel in tires and axles is so great that it might not unreasonably have been assumed that, by common consent, engineers and manufacturers would have arrived at certain definite qualities for these purposes respectively. To ascertain whether this was so the author recently obtained half a dozen pairs of tires and axles from as many of the leading makers at home and abroad, and submitted the same to the tests briefly detailed hereafter. No particular mode of manufacture was specified, nor were any conditions imposed as to price.

The results were startling and unsatisfactory. Not only was there no uniformity in the quality of steel supplied by the several makers, but even the two tires of the same maker, as a rule, differed widely in behavior under test. Thus the tensile strength of the steel in the twelve tires ranged from 32·25 tons to 49·5 tons per square inch, and the extension from 5 per cent. to 25 per cent., while under the "drop-test" one tire might fail at the second blow of a weight of one ton falling 10 feet, and the next only do so at the twelfth blow from the increased height of 30 feet, the respective bendings before fracture varying from no less than $\frac{9}{16}$ in. to 28 in. in the 3 ft. tire.

Similarly the tensile strength of the steel in the axles ranged from 27·35 tons to 40·7 tons per square inch, the extension from 17·6 per cent. to 23 per cent., and the number of blows sustained before fracture from 3 to 35. It will be seen hereafter that a high rate of elongation affords no guarantee that a tire or axle will behave well under the drop-test, and probably no efficient substitute could be found for the rough and ready test of endurance afforded by the bending and straightening blows of a weight of one ton falling 20 ft. or 30 ft.

Tires.—The tests applied were:

1. A steady bending pressure, to ascertain the elastic resistance of the tire to collapse.

2. Successive blows from a weight of 1 ton falling 5 feet, 10 feet, 15 feet, 20 feet, 25 feet, and 30 feet, to determine the endurance of the tire under shocks and blows.

3. A steady pulling stress to ascertain the ultimate tensile strength and elongation of samples of steel cut from the tires.

* From the Proceedings of the Institution of Civil Engineers.

The tests were conducted in all instances either by the author, or by Professor Kennedy, M. Inst. C. E.

The tires were of ordinary cross section, and weighed on the average 427 pounds each. The two samples of the several makers are referred to as a_1 and a_2, b_1 and b_2, etc., in the ensuing table:

Sample.	Approximate Elastic Resistance to Collapse.	Permanent Set under 40 tons.	Ultimate Tensile Strength.	Percentage of Elongation in Length of 5 in.	Extent of Bending under falling Weight. After Third Blow.	After Fifth Blow.	After Eighth Blow.
		In.	Tons per square inch.	Per cent.	In.	In.	In.
a_1	38 tons.	0·05	49·50	14·0	2¾	6¼	13⅞
a_2	not taken.	..	49·48	14·0	2¾	6½	13⅞
b_1	38 tons.	0·05	46·43	18·6	3	7 9/16	15⅝
b_2	not taken,	..	40·9	23·6	3	7½	15⅝
c_1	"	..	44·21	8·0	3 9/16	broke at fourth.	
c_2	36 tons.	0·07	42·48	5·0	4⅛	broke.	
d_1	not taken.	..	42·51	19·6	broke.		
d_2	33 tons.	0·18	37·36	5·8	broke at second.		
e_1	36 "	0·05	38·85	24·4	3⅝	broke.	
e_2	not taken.	..	38·01	25·0	4	10⅛	20⅝
f_1	"	..	34·67	14·5	5 5/16	broke.	
f_2	29 tons.	0·60	32·25	12·0	5⅛	11⅛	24⅝

NOTE.—The moment of resistance of the tire being 5, the bending moment 5 W, and the average elastic tensile resistance of the steel 22 tons, the elastic resistance to collapse might have been wrongly calculated to be 22 tons also; but for reasons set forth in the author's paper "On the Practical Strength of Beams,"* it would have been more correctly assumed at about 22 tons × 1·7=37 tons.

Axles—The tests applied were:

1. Successive bending and straightening blows from a weight of one ton falling 5 feet, 10 feet, 15 feet, and 20 feet, and continued at the latter height until failure occurred. The axles were placed on solid bearings 3 feet apart, and were turned half round after each blow.

2. A steady pulling stress to ascertain the ultimate tensile strength and elongation of samples of steel cut from the axles.

The axles were nominally 4 inches in diameter, but ranged from that figure to nearly 4¼ inches. The makers are referred to under the same letters as in the previous table:

Sample.	Diameter of Axle.	Ultimate Tensile Strength.	Percentage of Elongation in Length of 5 in.	Extent of Bending under Falling Weight. 10 Feet.	20 Feet.	Number of Blows Causing Failure.
	In.	Tons per sq. in.	Per cent.			
a	4	27·79	22·0	2⅞	4¾ in. to 5⅝ in.	35
b	4½	40·7	20·6	1⅝	3⅝ in.	8
c	4½	36·85	22·0	2¼	broke at 15 feet.	4
d	4 1/16	27·35	23·0	3	4⅝ in. to 5¼ in.	34
e	4 1/16	31·15	19·4	2⅞	4⅝ in.	14
f	4½	32·34	17·6	2⅝	3⅝ in.	6

Comparing the above with the previous table the following conclusions would appear to result:

1. Maker *a*, adopted for his tires a steel of high tensile resistance, uniform in quality, with a medium amount of elongation, and capable of standing several blows from one ton weight falling from the full height of 30 feet. For his axles he used very mild steel, having 43 per cent. less tensile resistance and 50 per cent. more elongation than the tire steel, and of great endurance under the drop-test.

2. Maker *b* apparently preferred a medium quality of steel for both tires and axles, and as a consequence his tires were not so hard and strong as the *a* tires, and presumably not so durable, while his axles were much harder, and failed with comparatively few blows under the drop-test.

3. Maker *c* supplied a couple of moderately hard tires, but the steel had a dangerously low rate of elongation, and failure quickly resulted under the drop-test. The axle was somewhat softer than the tires, and had a satisfactory rate of elongation, but signally failed to withstand the shock of the falling weight.

4. Maker *d* used a fairly hard but very untrustworthy quality of steel for his tires, as evidenced by the wide difference in the ultimate strength and elongation of the two tires, and by the snapping of both with a slight blow under the drop-test. His axle, on the other hand, was of mild steel of suitable tensile strength and elongation, and behaved exceptionally well under the drop-test.

5. Maker *e*, though his tire steel was of uniform tensile strength and elongation, did not succeed in securing uniformity of quality. Although the steel was too soft for good wearing purposes, and had a high rate of elongation, one of the tires failed with half the number of blows that the second and several other much harder tires sustained. The axle was somewhat hard, and suffered correspondingly under the drop-test.

6. Maker *f*, like maker *b*, apparently used the same steel for both tires and axles, but of a much milder quality. Notwithstanding its softness, the steel did not prove uniform and trustworthy, as the axle broke at the sixth blow with a bending of 3⅝ in., while one tire bent 27⅞ in. before fracture, and the other only 8⅝ in.

It may be interesting to remark that samples of steel from axles supplied in 1868 by maker *a*, and in 1862 by maker *b*, were tested by Herr A. Wöhler in his celebrated series of experiments on the "fatigue of metals."† At the dates named it may be inferred that the former maker was in the habit of supplying steel for axles having a tensile strength of from 26 tons to 29 tons per square inch with a rate of elongation of from 16 per cent. to 20 per cent., and the latter maker steel having what would now be considered in the case of axles the dangerously high tensile resistance of from 48 tons to 50 tons with an elongation of from 11 per cent. to 18 per cent.

The conclusion the author draws from his experiments is, that it would be imprudent, on the part of an engineer, to leave the quality of steel either for tires or axles to the discretion of a manufacturer, or to forego the most rigid system of inspection. An occasional test is of little use, because the most inferior materials may at times accidentally produce a good result; but to insure a good result and perfect uniformity in quality the best materials and the greatest care in manufacture are absolutely essential. The tabular results show that a sample of steel may be cut from a tire or axle, and be tested with perfectly satisfactory results as regards tensile strength and elongation, and yet that the tire as a whole may fail under moderate shocks, either on account of the steel being inferior in some respect which those tests do not detect, or from its not being uniform in quality throughout. Similarly as regards the axles. Mildness, great elongation, and an ability to withstand the "temper" test, do not always insure the steel being able to withstand the shocks and jars of traffic. Half a dozen specimens may be cut for testing from a given axle and yet some weak spot in it escape notice. It has been frequently proved, both by chemical analysis and by physical tests, that a bad ingot, or a steel rail rolled from it, differs widely in composition and strength from point to point, and the same holds good with a bad steel axle. A severe blow, either under the drop-test or in actual working, tries every part of the tire or axle, and finds out the weak spot, if there be one, whereas by almost any other test there would be a chance of the fault remaining undetected.

Assuming the steel to be of good materials and to be uniform in quality, it remains to be decided what degree of hardness is most desirable in the case of tires and axles. Experience has proved that steel, having a tensile strength as high as 50 tons per square inch, is quite trustworthy for use in tires in ordinary climates if the tire will stand a proper drop test. Similarly experience in shipbuilding yards and elsewhere has led to the specification of mild steel having a tensile strength of from 26 tons to 32 tons per square inch, that quality being found best able to sustain without injury the contingencies of working. Probably a limit of 46 tons to 50 tons in the case of tires, and of 27 tons to 30 tons in that of axles, with proper drop-tests, would, on the whole, be the best to specify in order to secure the most suitable steel for the respective purposes.

TEST OF HEATED STEEL.

SOME very important experiments on the influence of temperature on iron and steel have been carried out by the Admiralty at the Cyclops Works, Sheffield, and Mr. T. F. Barnaby's report to the Controller of the Navy on these experiments has just been issued. The testing apparatus is illustrated by the accompanying engraving, which explains itself. Mr. Barnaby says: By the kind permission of Messrs. C. Cammell & Co., John Brown & Co., and the Bolton Iron and Steel Co., I have been able to make tests on steel made both by the Siemens and Bessemer processes, and on iron of B. B. Boiler and Bowling quality. I have inclosed a sketch to show how the samples were heated and broken in oil or sand at the Bolton Works. I have endeavored to be as accurate as possible in determining the various temperatures, and when not able to do so with a Fahrenheit thermometer which registered to 600 degrees, I have taken the color visible on the fractures of the samples as a means of determining temperatures, in accordance with tables given by Mr. J. S. Jeans in his work "On Steel," *vide* page 615; and by Mr. D. K. Clark in his "Tables for Engineers;" and others. The tests, etc., which I have made, although done with care, are only comparative, and I am of opinion that with specially designed apparatus much valuable information may be obtained by further experiments and tests, which I think would quite dispel any fear that may exist in the minds of engineers and others as to the use of—properly manipulated—mild steel for boilers, etc.—*vide* page 41 of "Experiments on Steel," issued for the information of Board of Trade surveyors, with the remarks of the engineer surveyor-in-chief and his assistants.

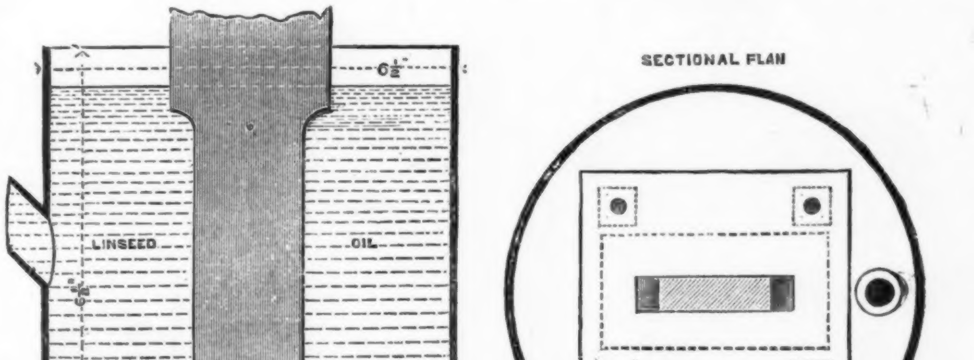
"The plates of superheaters, when inclosed wholly or partly in the uptakes, are often heated to a temperature equal or exceeding that which has been found to affect the steel so prejudicially, and in the absence of a full series of experiments to ascertain the exact loss of the tensile or crushing resistance, it is prudent either to dispense with such structures or efficiently protect them by shield-plates from the contact of flame or hot gases."

I beg further to state that I have other tests in hand which will range from the ordinary temperature of the atmosphere up to 400 degrees or 430 degrees, as most of the samples shown are above these temperatures. I am, therefore, of opinion that, from the nature of the results of these experiments, there need be no fear with respect to the use of steel for boilers, or where it may be affected by heat, but that it can be used with all confidence, as the tests, so far as I have been able to go, prove that Bessemer steel heated to about 400 degrees is about ten tons per square inch stronger than when in its normal state, while but one third only of its ductility is lost. Heat does not seem to affect steel made by the Siemens process to the same extent in tensile strength as it does Bessemer, but the elongation is affected to a like degree. This increase in strain and decrease in ductility is maintained more or less up to 600 degrees; beyond this temperature it requires further experiments before any conclusions can be arrived at, as at 880 degrees, or at a very dark red only visible in the dark, there is a great drop in tensile strength, but the ductility is still above the percentage required. With respect to B. B. iron, or that of Bowling quality, it will be seen that there is a rise of about three to four tons per square inch in the tensile strain, and a loss of one-fourth to one-half the ductility. This report is dated October 1, 1881, and is accompanied by several tables.

On October 13, Mr. Barnaby reported again to the Controller on a series of tests he had made upon mild steel of the quality supplied to the dockyards by Messrs. Charles Cammell & Co., John Brown & Co., and the Bolton Iron and Steel Company.

"I have made," he writes, "these experiments and tests to ascertain, if possible, the quickest and best method of treating steel after it has been in the hands of the shipwright or smith, and has been heated any number of times, to work the material to the forms required, as well as to show what in my opinion is a safe and quick method of dealing with butt straps and butt covers to angles which have been punched, and, in fact, in all small jobs done to steel by the shipwright or smith at the fire or punching-machine, and beg most respectfully to state that, from the nature of the tests I have made, and the results obtained, I am of opinion that it is quite safe in all cases, after the steel has been punched, sheared, or heated and worked to forms such as joggles and corners for watertight work, etc., for the workman to heat it gently over the part he has been working to a bright cherry-red heat, and then quench it in boiling water or oil, which has the effect of toughening the material, and does not make it in any way brittle or unsafe, while at the same time the ductility is only affected to a very slight degree, and, further, the quenching in boiling water has the effect of removing all scale from the material. As soon as the article or material thus treated has got to the temperature of the water, it is quite safe to take it to the ship or otherwise and put in place. If it should alter its form in any way by being placed in the water, it will be quite safe, in my opinion, to reset it to mould at once, or when cold.

"In the case of butt straps or butt covers to angle bars, in fact all articles punched or sheared, I am of opinion, if they are heated to a cherry red and quenched in boiling water, all the damage done by the punching or shearing will be removed, and the workman will be able to drift the holes, if necessary, and work the material in the same way as he would if it had been annealed. The samples tested prove that the material is not much injured by the heating and working, providing it be done with ordinary care. In one case I have taken a soft Bessemer plate, and in the other a Siemens just above the prescribed strain, and find that the samples, after all the work described has been put on them,



APPARATUS FOR TESTING HEATED STEEL.

* *Vide* Minutes of Proceedings Inst. C. E., vol. lxii., page 251.

† *Vide* Ueber die festigkeitsversuche mit eisen und stahl. Berlin, 1870

and they have been broken in the testing machine, that the pieces may be punched and will stand bending, even across the parts which have been worked, to the extent required for plates of their thickness, and at the same time will stand punching and bending across the holes in a satisfactory manner.

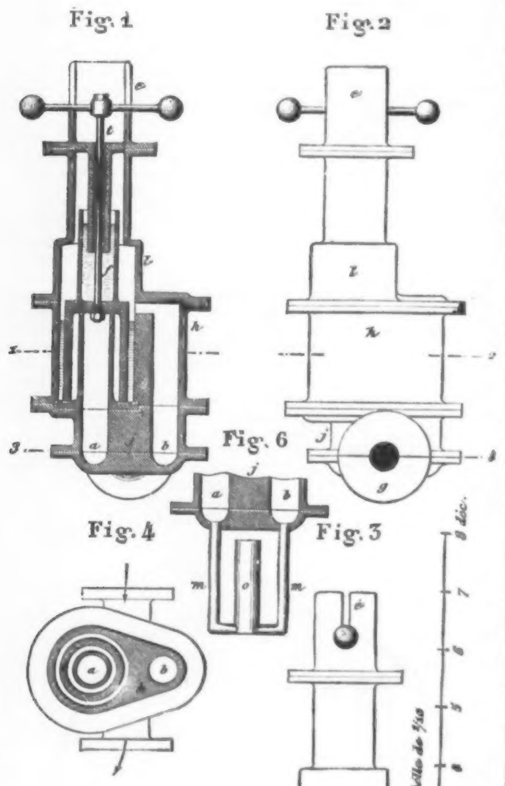
"All samples which have been quenched in boiling water after the holes have been punched, have been closed, or bent to 180 degrees across the holes, without a sign of fracture; others have stood drifting cold (after being drilled) to twice the size of the original holes before fracture. I have also made tests on angle bars, beams, etc., and find that forge tests made after quenching in boiling water are equal to those made after annealing.

"I beg further to state, it is my experience, after bending over 100,000 shearings, that even the quenching in cold water removes the damage done in shearing, and pieces which would not bend cold without planing have bent freely to the required curves after being quenched in cold water; but by the use of boiling water far better results are obtained. It will be seen that if the material can be treated in this way there is a great gain both in time, labor, and expense, at the same time the scale is removed, and the material retains its good properties, viz., strength and ductility."

It will be seen (says the *Engineer*) that these experiments contradict a government report issued last year, which went to show that at comparatively low temperatures steel became quite brittle and unsafe. How the two reports are to be reconciled it is for the authorities to say.

JARRE'S HYDRAULIC JOINT CUT-OFF.

MR. JARRE, a civil engineer of Ornans, France, has devised a cut-off with hydraulic joints, designed to be substituted in gas mains for the cocks of large diameter which are in ordinary use, and which it is difficult to render tight. Mr. Jarre's



JARRE'S HYDRAULIC JOINT CUT-OFF.

device is easy to keep in order, is absolutely gas-tight, and has been in use for the last two years at the Ornans gas works, where it has given excellent results.

The apparatus consists essentially of a bell inverted in a mercurial or water bath, after the style of the bell-glasses used in laboratories for collecting gases. At its upper part, this bell carries a rod provided with a screw-thread which engages in a stationary nut, and which permits of raising or lowering it more or less. When the bell is lowered the liquid by which it is surrounded suffices to prevent the flow of the gas, which remains imprisoned beneath. The cock is then closed. When, on the contrary, it is raised, it leaves the bath of liquid into which it dipped, and gives a sufficiently wide space for the flow of gas to avoid all choking up of the liquid vein. The cock is then open. Instead of passing the rod through a stuffing-box, Mr. Jarre employs a second hydraulic joint, which is formed around the maneuvering rod, and which secures the isolation of the mass of gas when once the bell is raised.

A certain quantity of liquid is necessary for the operation of the apparatus, and a calculation of this is given in a note accompanying the inventor's communication to the Société d'Encouragement. The hydraulic joint into which the rod passes allows of the introduction into the apparatus of the quantity of liquid that it may be deemed proper to add. This additional liquid is received in a small reservoir which communicates with the tube surrounding the bell. If too much were poured in, the excess of liquid might be apt to overflow beneath the bell into the gas pipe, and thus form an obstacle to the passage of the gas. Such a danger is prevented by adapting beneath the two chambers through which the current of gas passes a system of communicating tubes in which the liquid collects, and from whence the excess may flow to the outside through a tube serving as an overflow, and ending in the open air.

DESCRIPTION OF THE FIGURES.

Fig. 1, vertical section of the apparatus. Figs. 2 and 3, external views. Fig. 4, horizontal section, through 1 and 2. Fig. 5, horizontal section, through 3 and 4. Fig. 6, vertical section through the lower part of a cut-off provided with safety tubes.

(The same letters indicate the same parts in all the figures.)

a, conduit through which the gas enters the apparatus. *b*, conduit through which it makes its exit from the apparatus. *d*, bell, capable of being raised by means of the rod, *t*. By giving a quarter-turn to the latter, when the bell is raised, the knob in which it terminates rests on the edges of the slit in the cylinder, *e*, and keeps the bell raised.

Into the annular space containing the bell there is put a certain quantity of some liquid, such as water, mercury, etc. The dimensions of this space and of the bell are such that, the latter being raised, its lower edge no longer touches the liquid; the gas then coming in at *a* passes under the bell and makes its way to *b*. When the bell is lowered it dips into the liquid, which lowers in the interior of the bell and rises externally to it, in such a way as to balance the pressure of the gas. The column of liquid which balances the pressure of the gas has for its maximum height the height of the bell.

f, a large tube which surmounts the bell, *d*, and forms part of it. This tube also contains a certain quantity of liquid in order to form a joint around the rod, *t*. *g*, the bottom of the cut-off, and *j*, a piece connected with it. These two pieces form two flanged tubes. *h*, a piece surrounding the bell, *d*, and forming the annular chamber which contains the liquid into which the bell dips, and forming a continuation of the outlet tube, *b*. *l*, the cover which incloses the bell, *d*. *e*, a cylinder containing a slit to allow of the passage of the knob. The bottom of this cylinder closes the apparatus, and carries a tube which surrounds the rod, *t*, and which descends into the large tube, *f*. The liquid that *f* contains forms a joint between the rod, *t*, and the tube which surrounds it. If, for any cause whatever, liquid has to be added to the apparatus, it is done by pouring it into the bottom of the cylinder, *e*. The liquid descends along the rod, *t*, fills the tube, *f*, and spreads itself throughout the annular space which surrounds the bell. If the liquid be introduced in excess it will flow into the conduit. In certain cases it is necessary to avoid such a result. For this purpose (see Fig. 6) there start two vertical tubes, *m m'*, from the bottom of the conduits, *a* and *b*, and connect beneath with a third vertical tube, *o*, whose height must be equal to that of the bell, *d*. If the bell is down, pressure will exist only in the conduit, *a*, and the liquid will descend in the tube, *m*, and rise in tubes, *m'* and *o*, in such a way as to balance the said pressure.

If the bell be raised a pressure will be set up in the two conduits, *a* and *b*, and the liquid will descend in the tubes, *m m'*, and rise in the tube, *o*, in such a way as to balance the pressure.

If too much liquid be introduced into the apparatus it will make its exit through the tube, *o*, which cannot in any case allow a passage to the gas, since its height is equal to that of a column of liquid forming an equilibrium with the maximum pressure.

TIPPING AND SCREENING COAL.

AT the Clay Cross Collieries three sets of Rigg's patent tips and balanced curved screens have been in operation some time, alongside several working upon the old principle. The particular seam worked where these appliances are placed is very valuable, and fetches a high price in the London markets. But the coal is as tender as it is valuable, and like most others is not, as worked, absolutely free from inferior matter. It is essential that this coal should be dealt with gently in tipping, so as to make as little slack as possible,

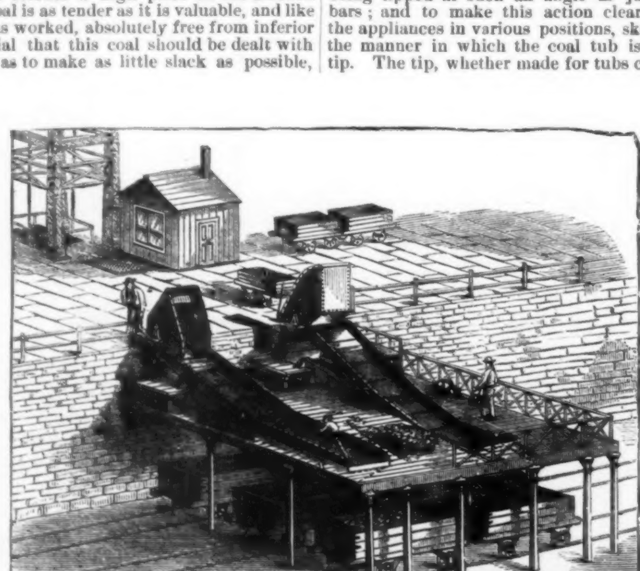


FIG. 3.

and as much round coal. Also that it should be thoroughly screened and picked so as to leave nothing but good clean coal upon the screen. The last requirement is that the coal should be deposited in the wagons without breakage. It is not too much to say that these conditions cannot be fulfilled, and are not fulfilled with ordinary fixed screens. So impressed are the Clay Cross authorities with the vital importance of dealing with the coals properly on reaching the surface, that a system is in operation which may possibly commend itself in other parts of the country. Every tub is numbered, and a record is kept of the numbers tipped into each screen and into each wagon, so that should complaint arise it is known exactly with which tubs and at which screens any wagon was loaded. Having fixed screens and balanced screens at work side by side, no better test could possibly be had as to their respective merits, and at Clay Cross the balanced screens have proved themselves the most profitable to the proprietors, and the most efficient to the customers.

We now offer some illustrations and descriptions of what

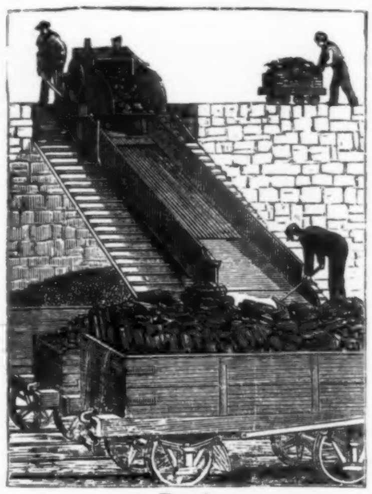


FIG. 1.

has proved itself to be the most efficient method of tipping and screening, and first we deal with the tip, the object of which is to discharge the coals quickly without breakage, and this is accomplished by the tip as shown, which is constructed to deposit the coals upon the bars without injurious velocity or fall. The next point is to receive the coals when tipped upon screen-bars, which will effectually allow the slack to pass through and retain the round coal upon the bars.

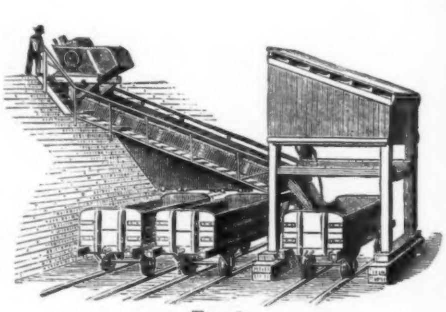


FIG. 2.

The wrought iron shoot in which the screen bars are placed can rotate to such an extent as to invert itself when coal is being tipped at such an angle as just to move over the bars; and to make this action clear, the sketches show the appliances in various positions, sketch No. 1 showing the manner in which the coal tub is retained within the tip. The tip, whether made for tubs containing only 5 cwt. or as much as 30 cwt., are exactly balanced and self-acting in their forward and return movement, and under the easy control of one man. They deposit the coal upon the plate at the higher end of the screen, from which it passes gently on to the bars, thus insuring a more perfect separation of the qualities than is possible with tips which simply throw their contents in a mass upon the screen bars. This sketch shows the tip half inverted into the screen, but retaining the coal. Sketch No. 2 gives an illustration of a double-fixed screen which is composed of metal throughout, the sides and hoppers being iron, and the screen bars of a special section of steel, combining lightness and strength. These

bars are supported upon plates cast in leaves, and between improved variable dividing plates, enabling the pitch in the distance between the bars to be easily altered to suit the different seasons and varying requirements of the markets Sketches 3, 4, and 5 show in perspective and side elevation each position of the tip and curved balance screen, to which special attention is directed because it meets more completely than any other arrangement the objections to fixed or balanced screens for tender coal requiring picking, also because it delivers the round coal nearer the floor of the wagon than any other, and it leaves the screen at a pace only

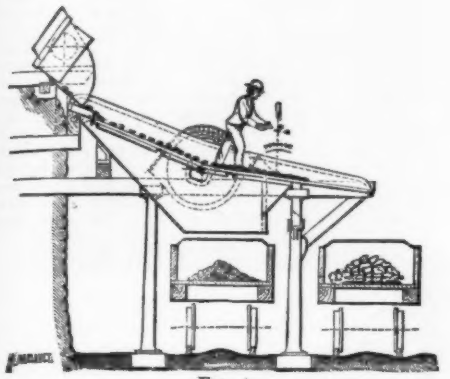


FIG. 4.

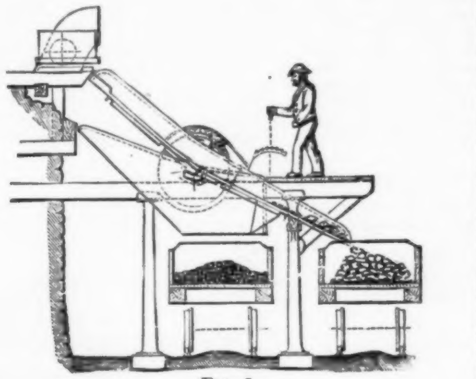


FIG. 5.

sufficient to overcome friction, thus entirely obviating the breakage due to the velocity at which round coal leaves fixed screens. This remark applies equally whether there are fixed platforms or doors at the ends of such screen or not.—*Colliery Guardian.*

CHAPEL AND VILLAGE HALL.

THE chapel and village hall which forms the subject of the illustration is to be proceeded with shortly at a village called Beyton, in Suffolk, and has been designed by Mr. John T. Woodard, architect, Southampton Street, Strand, W. C., merely as a rustic chapel suitable for the requirements of a small village and a limited congregation. The ground plan is nearly rectangle, the body of the meeting hall being made octagonal, while three of the angles at one extremity of the ground are utilized for a platform, with a vestry on one side and an ordinary recess room on the other. —*Building and Engineering Times.*

TRAIN DISPATCHING ON A BOSTON ROAD.

NOT long ago, near a station on the Old Colony Railroad, only a few miles out from the main depot in Boston, an incoming freight train accidentally had one of its long cars derailed. At the point where the accident occurred the road is double-tracked, and the car was thrown in such a position that it lumbered both tracks, presenting for a time a complete barrier to all outgoing and incoming trains. The methods for action in such cases on the Old Colony, as well as on every well-regulated railroad, are most clearly defined and well understood by the employes; and in the shortest possible time workers were at hand from headquarters, and the wreck in process of clearing. From the time of the accident until first one and then the other track had been cleared, only a small number of minutes was consumed; the tracks were repaired, and matters soon resumed their usual routine. A slight incident in railroad affairs, one will say, and hardly worthy of detailed mention.

But when the lives of men, millions of dollars in property, and myriad interests of humanity are included and concerned in one economical system, details, be they ever so minute, are never trivial or uninteresting. The immediate consequence of that little accident to a freight train, although not apparent to those nearest the scene of disaster, were as far reaching as the Old Colony system, and included detailed working on every part of the road, while at the same time they called into exercise the utmost vigilance and experience of the headquarters of the road. Here was an emergency which would prove the value and utility of the methods of management of the road, and demonstrate whether or not these methods were sufficient for its government under all circumstances. As the general subject of train running is well illustrated by this example, it will be here a little further pursued.

By this apparently unimportant accident, 55 trains of various grades and qualities were within a few minutes time brought to a standstill upon different parts of the Old Colony system. These were express and accommodation passenger trains, express and time freights, regular and irregular trains, passenger, freight, and mixed, some wild trains, gravel and construction trains and, possibly, some excursions. It will be observed that the accident occurred near the main depot in Boston, at a point where outgoing and incoming trains to and from every part of the system are passing every few minutes during the day. It was a point toward which trains near and remote were hurrying, and which must be passed by all trains bound outward to any division of the Old Colony service.

Now the Old Colony system is about the most complex and cut up of any railroad service in New England—or anywhere else, in fact. Its central points, from which division lines to various sections radiate, are numerous, while its branches, short cuts, loops, and feeders are of far greater number. It has about 475 miles of road and not far from 190 regular stations; and on its lines, during the busy portions of the day, between 60 and 70 trains are in motion at one time, crossing, diverging, approaching, succeeding, and, in one sense at least, always hurrying. A very large portion of the road is single-tracked, although its most busy portion is double-tracked.

It will be readily appreciated that to keep so large a number of trains in motion at one time, on the same railroad system, implies a rigid requirement that each train shall be somewhere near a given point of track at a particular moment; and that somebody in interest must know all about these trains and points, and be able intelligently to control with exactness almost every movement on every part of the system at all times. And this is precisely the case; and the train-dispatcher is the man. Since the perfection of the telegraph, and its application to the system of daily life and business, railway trains are almost universally run by it, although its use is supplemented by time-cards, and usually the most elaborate system of rules and regulations that can be devised, the peculiarities and experiences of each road causing some little variations to suit circumstances and surroundings, while generally the methods and practices do not differ widely.

The train-dispatcher, then, sitting at the telegraphic instrument at headquarters, with a number of assistants in corresponding positions to make the service complete, is king of the situation all the day long, so far as the movement of trains on the lines of his company is concerned. In every important station (and nearly all are reckoned important in this sense) on the lines there is also an instrument and an operator present or near at hand in many of them during day and night, and always by during the movement of trains that should pass that way. The rules for these operators are "cast-iron," as are also those for conductors and

CHAPEL AND VILLAGE HALL, BEYTON, SUFFOLK.

engineers, and it is a rare combination of circumstances, indeed, which is not covered by the directions for the actions of all these worthies.

Following out the instance of the Old Colony: In the early morning hours trains from the country arrive thickly, and outgoing trains are almost as plenty. At corresponding hours in the evening this preponderance of trains is again noticeable; while in the intermediate hours of the day the tide flows usually not quite so strongly. In the train dispatcher's room is a chart, made up of perpendicular lines drawn upon a great paper sheet, every line and space indicating a minute of time, the lines so close together that the indications for an hour occupy but one and three-eighths inches of space altogether, measuring across the lines. Horizontal lines cross these time lines and spaces, so arranged as to represent the exact number of miles from the main station of the subordinate station. On some roads these perpendicular lines are five minutes apart; but on the Old Colony lines each perpendicular line and intermediate space represents a minute, as stated above. The chart is large enough to represent consecutively every hour in the day, minutes being designated regularly by tens at the top of the chart, and station and miles and fractions of a mile upon its sides, opposite the horizontal lines, as well as at reguler mile intervals.

Knowing, then, the time of departure of a train from any point, say from Boston, the dispatcher notes its progress. Following thus the direction of a passenger train leaving Boston at precisely 8 o'clock, A.M., he sees it pass through the horizontal line representing Neponset station exactly 11 minutes from Boston, and by reference to the figures on the side, next the Neponset line, 4·75 miles distance from Boston are indicated. But, at 8 o'clock, the starting moment above set forth, there left a train from Crescent avenue, 2·21 miles from Boston, and another from Atlantic, 5·35 miles from Boston, both the last-named being bound for Boston. In fact, by the time the train first mentioned (as leaving Boston at 8 A.M.), has got 10 minutes out from Boston, it will occupy the section of the road between Boston and Neponset with three other trains, three moving inward toward Boston, and itself speeding outward.

And this increase of companionship continues throughout its course, until, as has been indicated, between 60 and 70 moving trains occupy the iron at different points at the same time. Now, the dispatcher, sitting at his post, sees that these moving trains must meet or pass each other at one of these time lines or spaces, and just so far from one of the stations, and his chart indicates exactly where and when the meeting will take place, provided everything is in exact working order on every part of the lines. If the road is double-tracked, trains may pass each other between stations; if the track is single, they must pass at stations, or by the use of sidings or turn-outs.

Now, referring back to the opening statement of this writing, note the confusion caused by the blocking of both Old Colony tracks, at a point so near Boston, where business is heavy nearly all the time. The nearest approaching trains to the scene of the accident must be stopped at once. If they are dangerously near the blocked track, a flagman sent out for the purpose from the train meeting with disaster will stop them on the open track; and one may be sure that the flagman departed on his important errand the moment the lumbering freight car turned tail upon the tracks. Should an express train, flashing past stations at two-minute gait, be next in order, it will be brought up standing at the nearest station before the accident is five minutes old, checked by a red flag or signal displayed by the station agent, who was moved to such enterprise by a clicking command of the train-dispatcher at headquarters.

And now, thick and fast the orders fly. More than 150 private telegraph operators are at their posts, noting, with practiced eyes and ears, every indication of the subtle messenger they manipulate. Clanking, clattering freight trains roll into stations, and incontinently roll out again upon sidings behind old buildings or wood piles. Passenger trains come puffing up, creating a stir in depots 5, 10, 20, 50 miles from the scene of the accident. The conductors jump to the platform; critically examine watches; receive, without a sign of impatience, the lowest spoken communication of the telegraph operator; pass a word or two with the engineer, and disappear into some cuddy or corner beyond the ken of station loafers or waiting passengers. The fireman seizes an oil-feeder or a handful of waste, slinging, meanwhile, a few gags at the switchman, with whom he usually has some unsettled accounts in the way of practical jokes, which may be enlarged, or perhaps contracted, if the wait is a long one.

One thing is noticeable at all these stations and among these waiting employes: There is apparent no disposition to rebel, nor even growl too loudly at fate. If it is desirable in a soldier or a sailor that he should know how to obey orders implicitly, it is the grand "must be" of the railway train official or hand. Wherever the track is single, and trains are moving both ways, such stoppages as above accounted for are of life and death significance, and so, indeed, the railroader well knows. In these days the train official rarely moves without orders, and the system of orders is such that they can rarely be misunderstood or misapplied.

An idea may thus be obtained of the confusion caused by even a slight stoppage of a single train at a given point. Two or three minutes of delay to any train must inevitably, during most hours of the day, derange the system in many parts, while an hour's waiting demoralizes the whole line. It might be interesting, if space would here permit and the details could be collected, to show *Herald* readers how many trains are thrown out by the detention during two hours of an express train bound from St. Louis to Boston, the detention taking place in the first 100 miles of its progress. But the matter is illustrated imperfectly above.

The obstruction of the tracks having been removed, the train-dispatcher sets in motion again his demoralized fliers, watching, one may be sure, with an absorption of attention and intensity of concentration little dreamed of in ordinary employments. A minute too soon or too late with this or that train; a blundering order, or one not quite definite; the mistake of a minute or a mile—how many contingencies hang upon his knowledge and action! Not exactly a position in which to place a tippler or a thickhead, nor are such ever found therein.

During the wait the impatient passenger, seated in his comfortable car at some way station, grows restive as the moments wear away, frets his soul according to his make-up or disposition. "The slowest road in the world;" "This thing happens regularly every day now" (he may not have waited three times in a year); "Miserable management!"

"Conductor, how much longer are we to stop in this forsaken hole?" "This comes from having no competition!" The song is varied, but all the time unmusical and dismally minor. Could these passengers get a glimpse of the waiting trains posted in 50 other equally dismal localities; could they take account of the really distressing events actually occurring by this unavoidable, but no less vexatious, delay; the connections lost; the mourners delayed; the sick moaning in pain; the important engagements frustrated and transactions deferred or destroyed—how miserably selfish might their own foolish and senseless grumbling appear. Above all, could they be made to see clearly what might ensue, should a careless or incompetent train-dispatcher send them forward a moment too soon, a lesson worth improving might be imparted.

During the nights the freight trains kite about, trailing their lengths around curves and over grades, clatter-dashing through towns and villages, a minister of nightmare to others than the train-dispatcher. In the day time many of these erratic wanderers take their chances, like the coal trains from the Somerset yards of the Old Colony, running wild wherever and whenever they can be sent out, and visiting every section of the line. But, wild or regular, express or time, whatever the condition or degree of all these trains, the train-dispatcher regards them as moving comets which must never be allowed to collide. That he is so successful in preventing collision is simply wonderful.—*Boston Herald.*

THE PHOTOGRAPHIC FIELD-GLASS.

WHAT traveler is there who, before a picturesque scene, has not experienced a desire to have some means of preserving a less fleeting impression of it than that made on the memory? In most cases, one is neither painter nor draughtsman, and the ordinary photographic paraphernalia is cumbersome, and requires tiresome manipulations that only extended practice in can render successful. It is our intention to make known at the present time an apparatus which, it appears to us, should supply the want above indicated.

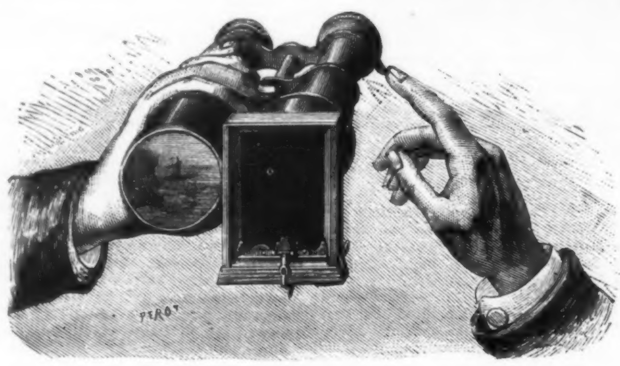


FIG. 1.—THE APPARATUS READY FOR USE.

This apparatus is the *photographic field glass.* It consists of an excellent glass, such as used for marine purposes, having a 54 millimeter objective. It is converted into a photographic apparatus by removing the objectives, which are mounted by a bayonet catch, unscrewing the eye-pieces and substituting for the latter photographic objectives. These latter (one of which is provided with a shutter) carry the numbers 1 and 2. It is necessary to have care to screw each of them on the side which bears the corresponding number inscribed on it. In place of the objectives of the field-glass, there is adapted on the side that carries the shutter a photographic frame, and on the other, the cap that holds the ground glass. The upper part of the photographic frame opens by a hinge, and it is there that the glass is introduced, with its sensitized side facing the circular opening closed by a movable curtain. This latter is opened by means of a spring which the operator tightens by pulling on the clasp that is seen at the back and base of the frame. The glass is by this means exposed, the sensitized surface facing the shutter, and being consequently turned toward the light.

The focus is obtained on the ground glass by acting on a small milled wheel as in an ordinary opera glass; and as the foci of the objectives are equal, and all parts of the apparatus are well-adjusted, the image which is at a focus on the ground glass is equally so on the sensitized plate. By acting with the finger on the shutter the objective is uncovered for a very short time, the plate takes the image, and an instantaneous negative is obtained. (Fig. 1.) The clasp of the curtain is disengaged, the spring loosens, and the curtain again closes, thus shielding the glass from any new luminous impression. The photographic frame is then removed, and a new glass is substituted for the one containing the negative. The introduction of the glass into the frame is made by means of the laboratory bag shown in section in Fig. 2. This bag is made of material impermeable to light, and is provided with two apertures which are closed by two rubber bands. These two apertures serve for the introduction of the photographic frame, of the glass contained in its case, and of the operator's hands. It is well when operating to cover the apertures of the bag with one's coat sleeves, so as to intercept all passage of light. The manipulation within the bag is very simple. The cover of the frame is opened, and after the glass has been removed from its case, it is introduced into the frame with its sensitized surface toward the light as above stated. As the sensitized surface is slightly rough to the touch, it is easy to recognize, without seeing it, the side which is to face the objective. The cover is then hermetically closed, and the frame is withdrawn from the bag and adapted to the field-glass, cover downward, care being taken to fix it very perfectly against the cylinder of the field-glass.

FIG. 2.—MANIPULATION IN THE LABORATORY BAG.

To obtain perfect success with the negatives it is important that, during exposure, the apparatus should be perfectly immovable. For this reason it should be placed on some sort of support or other, such as the top of a wall, trunk of a tree, etc. It is necessary, also, to have some practice in operating the shutter, so as not to jar the apparatus in the least while doing so.

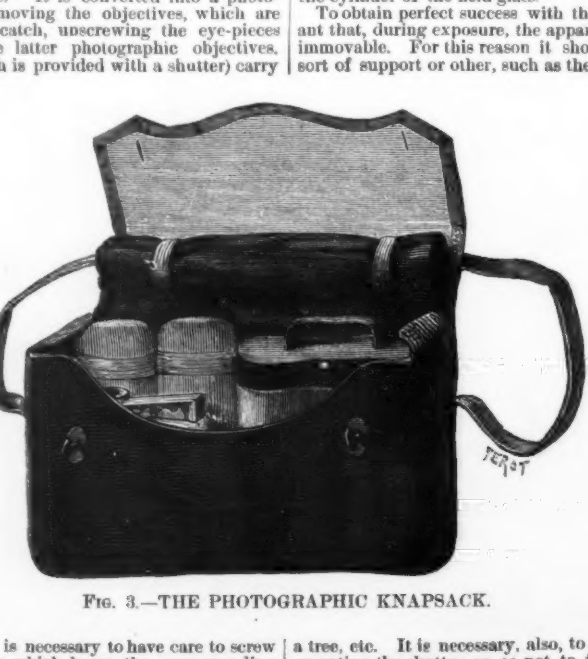


FIG. 3.—THE PHOTOGRAPHIC KNAPSACK.

The whole instrument is inclosed, along with twelve prepared plates, in a leather knapsack about 28 to 30 centimeters in length by 20 in height and 5 in thickness, which are about the dimensions of an ordinary traveling bag. (Fig. 3.) The development and fixing of the negatives is performed

as follows: In a dark chamber, lighted by a lamp provided with a red glass globe, or by a window glazed with glass of the same color.

The negatives, once taken, may be kept for several months before developing them, by keeping them dry, and not allowing them to be exposed to the light.

FIG. 4.—SPECIMEN OF PHOTOGRAPHIC VIEW TAKEN WITH THE APPARATUS.

Development.—Several negatives, say four, may be developed simultaneously by the following formulas. The inventor of the apparatus very particularly recommends that the negatives, both before and after the operation, shall be very carefully preserved from the access of the least light, otherwise each would become covered with a film, and hidden.

Formula No. 1.

Alcohol, 40°	150 grammes.
Pyrogallic acid	30 "

Dissolve about 5 grammes of sugar in as little water as possible, and add to the alcohol.

Formula No. 2.

Water	150 grammes.
Aqua ammoniæ	15 "
Chloride of ammonium	2 "

To develop the negatives, there is poured into a basin or other appropriate receptacle the following

Developer.

Common water	50 grammes.
Formula No. 1	3 "
" No. 2	3 "

This solution is to be shaken, and the negatives to be immersed in it until the details are lost through transparency, that is to say, until the plate presents a black and almost opaque film. Then the plate is taken from the developing bath and immersed in water for a few seconds, and afterwards fixed by putting it into a bath having the following composition:

Fixing Bath.

Water	200 grammes.
Hyposulphite of soda	30 "

When the negative is perfectly clear, that is to say, freed from bromide of silver, it is washed repeatedly with water, and allowed to dry perfectly, when it is ready for

Printing on Paper.—To print from the negative, the latter is laid, varnished side downward, on paper sensitized in a 14 per cent. nitrate of silver bath.

Albumenized paper may be found already prepared and sensitized in shops where photographic materials are sold; but, if the amateur wishes to sensitize the paper himself, he may do so by floating it for about three minutes in a bath of

Distilled water	100 centigrammes.
Nitrate of silver	14 grammes.

This paper, when dried, is cut into pieces the size of the negative, and exposed, beneath the latter, to the light in a printing frame devised for this purpose. When the proof has become blacker than it should appear when finished, it is immersed in a bath of common water, which is changed two or three times. Then it is toned by immersing it in the following

Toning Bath.

In one bottle put

Distilled water	1,000 grammes.
Neutral chloride of gold	1 "

In another bottle put

Acetate of soda	15 "
Phosphate of soda	15 "
Distilled water	1,000 "

Into the second bottle, the gold solution is poured drop by drop, the soda solution being strongly shaken after each addition. In twenty-four hours the bath is ready for use. Finally, when the proof has been toned to a dark blue, it is fixed in a bath of hyposulphite of soda of a strength of 14 per cent., in which it is allowed to remain for about 10 to 12 minutes. Afterward it is washed in a large quantity of water for about 6 hours, dried, and mounted on cardboard by means of dextrine paste.

Such is the photographic field glass. With it the traveler may preserve a durable image of his voyages; the artist, often pressed for time, will be enabled to take a faithful view of a landscape or other object; and the officer, on a campaign, will be enabled to obtain an accurate view of the configurations of soil of a military position, etc.

As has been seen, there are scarcely any immediate manipulations to be performed, the few that are being reduced to operating in a bag impermeable to light, in order to substitute a new plate for one that has already been exposed. These plates, being sensitized by gelatino-bromide of silver, are dry, and present none of the inconveniences of plates prepared in the wet way with collodion.

The subsequent manipulations may be deferred till returning home, and may then, if desirable, be intrusted to a professional photographer.

A NEW ANTISEPTIC COMPOUND, AND ITS APPLICATION TO THE PRESERVATION OF FOOD.*

By PROFESSOR F. BARFF, M.A.

FIVE or six years ago, while experimenting on methods for the preservation of food, I adopted a process which depended on the absorption of oxygen by some suitable substance, the food to be preserved being inclosed in hermetically sealed vessels. The substance I employed for this purpose was green vitriol, or protosulphate of iron; this was mixed with lime, or soda-lime, which rapidly decomposed it, setting free the protoxide of iron, and this absorbed all the oxygen in the vessel. Owing to the formation of sulphate of lime, which, when moist, sets in hard masses, the action was not always complete, as some of the protoxide of iron got locked up, and was so removed from the air; to prevent this, I rubbed up with the mixture some cork or oak sawdust to keep the mass porous, this assisted in the absorption of the oxygen, as either of these substances with lime, or better, soda-lime, itself absorbs oxygen; in fact, oak sawdust and soda alone, when moist, will absorb all the oxygen in any vessel containing air. Many experiments were made which proved conclusively that the whole of the oxygen of the air could be absorbed; and several specimens of raw beef were for a long time successfully preserved, but on most occasions when the vessels were opened, the meat, though looking perfectly fresh, had a very unpleasant smell, which rendered it quite unfit for food. After long investigation, the causes of this were discovered; some of the juices of the meat came in contact with the lime or soda employed, and ammonias were formed, which gave rise to these unpleasant odors. The difficulty in overcoming this defect was so great that I at last abandoned the investigation, and turned my thoughts in other directions.

It is well known that boracic acid is an antiseptic, but its very slight solubility in water renders it, by itself, useless as a preservative of meat. About this time a process was submitted to me, in which tartaric acid was used as a solvent for the boracic acid for the purposes of food preservation. I examined and reported favorably on the process. Specimens of meat treated by it were well preserved. For certain purposes of food preservation it had defects, although beasts injected with it were kept in very good preservation; yet, if the meat was soaked in the fluid, the meat was preserved, but in a very short time the fluid decomposed and stank. It was clear, therefore, that this material could not be used where its presence was required in the wet state, in the substances to be preserved, as in milk or cream. My idea was, then, to get something which would preserve the meat, or other food, and would itself not decompose; for, as I shall try to show before I conclude this paper, that however desirable it is to bring from meat-producing countries whole animals, yet there are other and cheaper methods of easing the meat market, in this and other countries, which should not be neglected. My object in this paper is not to say anything against any existing successful methods for bringing meat from abroad, nor do I wish in the least to interfere with them. The frozen meat process has given good results; it is founded in reason, and I wish it all success. But the quantity of food which we require, and the cheapness with which it can be obtained, are subjects which I am sure you will agree with me demand the attention of all scientific persons. I tried a number of experiments on solvents for boracic acid, but the result of my work was to show me that no mere solvent was the thing wanted; that some substance should be used which formed a definite chemical compound; for, if a definite compound could be found, then the substances used must always be in the same proportion, if properly compounded. Biborate of soda, or borax, is a solvent for boracic acid, but in using it a large quantity of soda is used which has no preservative action in itself, and could be dispensed with, except that it assists in acting as a solvent for boracic acid. Not to trouble you with the results of my abortive experiments, I will mention that glycerine came to my mind as a very likely substance for my purpose. It has great solvent powers, and then, it is a substance in which some of its hydrogen can be replaced by other bodies. The well known explosive nitroglycerine is glycerine in which some of its hydrogen has been replaced by NO_2, the radical of the nitrates. I found that glycerine, when heated, readily dissolved boracic acid, and I tried many experiments with it in the earlier stages of my work, but always there was a sweet taste, which was objectionable for any preservative substance. To be successful it must be free from any taste. Another reason for the use of glycerine was its well known property of arresting the growth of germs. Many experiments have been tried with it, an account of which may be seen in the last supplement of Watts's "Chemical Dictionary" on the subject of ferments. It was at first tried to get substitution products with boracic acid, similar to those obtained with nitric acid, and my friend, Mr. Paul, who has worked with me all through these investigations, is at present engaged on the subject, and with every prospect of success, so that I hope, before long, we shall be able to publish some interesting and satisfactory results. I have lately seen it asserted that boracic acid alone has not the power of preventing decomposition, but only in combination with other substances, and my own experience entirely confirms this statement. I will now proceed briefly to state the result of our experiments in the preparation of this compound for the preservation of food. Fats are composed of two bodies, an organic acid, or organic acids, chemically united with a substance called glyceril, the symbol for which is C_3H_5.

This glyceril acts as a base with which the acid is combined, therefore fats are salts, just as carbonate of soda is a salt, and one part of the salt, viz., the base, can be replaced by another base, and therefore a new salt can be formed. This is what takes place in the manufacture of soap. Soap is a salt in which the organic base of a fat has been replaced by a mineral base, such as soda. If some oil be boiled for a time with litharge, protoxide of lead, and water, the fat is quite decomposed; its organic acid unites with the oxide of lead, forming a lead salt with the organic acid, and the glyceril which is expelled takes up the elements of water, and becomes glycerine. Thus: $C_3H_5 + \begin{matrix}HO\\HO\\HO\end{matrix}$ becomes $C_3H_8O_3$, glycerine, and this glycerine can be collected and purified. This is one way in which it can be obtained, but when the fatty acids are wanted for special purposes, such as candle-making, and it is not wanted to have them in combination with other bases, glycerine is obtained by acting upon fats with superheated steam, and in this way it is set free, the fatty acids being left alone, the glycerine taking up the elements of water from the steam employed.

The substance which we obtain by the action of boracic acid, or glycerine, is a body analogous in its composition to fats; it consists of glyceril united with boracic acid instead of with a fatty acid. If 92 grammes of glycerine be mixed with 62 grammes of boracic acid, and if the two be heated together, an action takes place, and steam is given off. In conducting this experiment, it is best to heat the glycerine to a tolerably high temperature, and add the boracic acid in small quantities, continually stirring. The boracic acid dissolves rapidly at first, but toward the end of the operation, it takes a much longer time to dissolve. If the mixture be allowed to cool directly the boracic acid is all melted, a crystalline precipitate will be found to separate out. This precipitate is probably boracic acid, which has only been for the time held in solution, and has not gone into chemical combustion with the glyceril. If the mixture be now weighed, it will be found to have lost weight, for it will weigh 131 grammes, whereas at first, when it was mixed, it weighed 154 grammes. If tasted now, it will have a sweet taste of glycerine. After this mixture had been heated a second time, a crystalline precipitate again separated out on cooling, and during the whole heating process, steam was freely given off. When cold, its weight was found to be 116 grammes. Different experiments as to its solubility in water were tried, and as the chemical combination became more perfect, its solubility in water increased. After a third heating, on cooling, no crystalline precipitate separated out, but the mass, when cold, set into a hard mass, like ice; it was somewhat brittle, as ice is, and its surface, when struck with an instrument such as the screw-driver, broke as ice breaks; that is, it was readily chipped, and the small pieces were found to be hard and dry. The weight of the mass was now found to be 100 grammes. 154 grammes had therefore lost 54 grammes, and this exactly corresponds to the weight of three molecules of water, for one molecular H_2O weighs 18. Here is represented, symbolically, what took place:

$$\underset{\text{Glycerine.}}{C_3H_5\begin{matrix}HO\\HO\\HO\end{matrix}} + \underset{\text{Boric Hydrate.}}{H_3BO_3} = C_3H_5BO_3 + 3\,(H_2O).$$

Mr. Paul has often and carefully analyzed this ice-like glacial substance, and has found that it quite answers to this formula. It may be well to explain for those who are not well practiced in chemical formula, this equation in words. C_3H_5, glyceril, chemically united with 3(HO) forms $C_3H_8O_3$, glycerine; H_3BO_3 is the molecule of the hydric borate; B_2O_3 is the molecule of the boracic acid. Under the action of heat, the H_3 from the boracic acid unites with the 3(HO) of the glycerine, forming $3(H_2O)$, three molecules of water, and the BO_3 of boracic acid takes their place, forming $C_3H_5BO_3$. For my purpose to-night I think I have gone fully enough into the scientific part of the question. I have already mentioned that my friend, Mr. Paul, is working with me at the subject, and he will prepare a paper which will, I believe, be full of scientific interest.

The demand for food in this and in other densely populated countries is so great, that all methods for importing in a wholesome condition foods from food-producing countries must demand attentive consideration. When I first mentioned this matter to persons who knew the meat trade, the first remark made was, Does it alter the external appearance of the meat? I do not think that this is a matter of vital importance, and for this reason, salting meat alters its appearance, and yet people eat salt meat freely. Salt meat is not imported from distant countries, where it has to travel in hot climates, because so much salt is required to preserve the meat that it interferes with its flavor and nutritive properties; but suppose that meat mildly salted, such as is usually eaten in London, could be brought from Australia or South America, would its appearance interfere, therefore, with its sale? and suppose a very large quantity of the salted meat consumed in London and other large cities in England, and on the Continent, could be obtained at 4d. or 5d. a pound, would it not be a great boon to the people, and also would it not greatly ease the meat market, and tend to reduce the price of fresh meat at home? I make these remarks to prove that there are ways by which we can increase our food supply without bringing our meat to be exhibited in rivalry as to appearance and price with home grown, fed, and killed meat.

Do not understand me to mean that the process which I am describing will not bring meat to the English and other markets in a salable condition and perfectly fresh, having its true flavor; but what I want to-night to show as well is, that other methods can be employed in which a greater general saving can be effected than by the exclusive attention to producing foreign meats in quarters, etc., so as to be placed side by side on the markets with our own meat. I will just take the liberty of laying before you methods in which foods of different kinds may be imported adapted to particular requirements, and then I will conclude with some remarks as to the importation of beasts, whole or in joints. This evening I have on the table specimens of food which have been kept for longer or shorter periods, as they are intended to illustrate various applications of this preserving material. As you know, oysters are imported very largely in tins. They are cooked at a high temperature and hermetically sealed. The high temperature to which they are exposed necessarily causes a loss of flavor, and it is generally remarked that tinned oysters are not a success. This remark, however, requires some qualification, for the oysters tinned and supplied by some of the English firms are really very good, though not to be compared in any way to those freshly opened. I have eaten oysters tinned by Messrs. Crosse & Blackwell, when used for sauce or patties, so good that one had to think twice whether they were not fresh oysters. I have oysters on the table which were opened on the 3d December in last year. I will ask you to taste them, and see in what condition they are, and I would also remind you that they have not been kept in hermetically sealed tins, but simply in corked or stoppered bottles; hence this method of preserving oysters is cheaper than the other, and I maintain that it is more effective, because their natural and fresh flavor is preserved. I am informed by a friend in Jamaica that he has sent me some Jamaica oysters and other things—I trust they will be here in time for me to submit them to you this evening.

Another substance, the perfect preservation of which is very important, is cream, both for home use and for exportation. Cream in London costs from four shillings to five shillings per quart; it can be bought in country places for two shillings, and even for less. This preservative substance will keep cream for months perfectly good and sweet, having its full flavor; so that it would be quite possible to send it in quantities from the country, and its sale need not be pressed as it need not be used immediately. I have regularly every week, except during the holidays, brought with me from Beaumont College, near Windsor, where I lecture

* Lately read before the Society of Arts, London.

a quart of cream treated with one ounce of the boroglyceride; it has always kept perfectly good even in the hottest weather. I have done this for a year and a half; a near relative has taken the greater part of this regularly for the time stated, and this proves conclusively that there is nothing at all injurious to health in the compound. I see a gentleman here present to-night who is connected with that college as a professor of natural science, and he will, in the discussion, be able to give you very valuable information as to the material and as to its perfect wholesomeness. Last month I sent some cream to the Rev. J. Ryan, a Jesuit priest in Jamaica, and I have received a letter from him, from which I will read you an extract:

"26 NORTH STREET, KINGSTON, JAMAICA,
"February 24, 1882.

"The cream which you sent was used by eight of us in coffee, and was pronounced to be wonderfully good. Next morning it was taken in preference to a beaten egg, by the captain of H. M. S. Tenedos, to his coffee."

Last year I sent some Devonshire clotted cream, which I prepared myself, to Zanzibar, on the east coast of Africa. The climate here is very hot; fresh food will only keep a few hours. This cream had to pass through the hot climate of the Red Sea. I will read an extract from a letter written by a lady who received the cream:

"UNIVERSITIES' MISSION TO CENTRAL AFRICA,
"MBWENI, ZANZIBAR, March 8, 1881.

"The Devonshire cream you sent us was quite a success. I received it last night. Fortunately the Bishop and Miss A. ——— came to Mbweni to-day, so we had it for dinner. That I might have everything correct, I opened a pot of raspberry jam which we had from London a long time ago. The Bishop said it had kept perfectly, but had not quite the rich flavor that it has when quite fresh; he has been used to it in Devonshire. Every one pronounced it most excellent. We sent some in to Mrs. H.———, and were surprised at her sending for more, for she seldom eats half anything we send her. She did not know what it was, but she said she had never had anything here she enjoyed so much."

A year ago I sent some cream from Beaumont College dairy to the Rev. Thomas Porter, the head of the Jesuit Mission in the West Indies. He states that the cream was as good as any he had eaten at home, that he gave it to several strangers to eat, and that they would not believe that it came from England. These experiments and these testimonies prove conclusively that this compound will preserve cream. I shall this evening show you specimens. It is easy to send cream in good condition to the tropics. A great objection to condensed milk is that it is always too sweet. The boroglyceride will preserve condensed milk, and will give it no flavor at all. My friend, the Rev. Thomas Porter, sent me some articles preserved with the material, which I sent him from England; they arrived about June in last year. Some raw, fresh turtle came quite fresh. It was cooked and eaten by several persons, who said it was quite fresh and good, and had the flavor of fresh turtle. At my own house I had turtle cutlets fried; they were perfectly good, and tasted like turtle. Another article which Father Porter sent me was an uncooked Jamaica pigeon; it was roasted at Beaumont College. I divided it and brought half of it home; it was tasted by twelve people, who all pronounced that it was perfectly good, and had the true pigeon flavor. In the same parcel came some green sugar-cane, fresh tamarinds, taken direct from the tree, fresh limes, and the juices of two different fruits—all were fresh, and were tasted by gentlemen who had lived in Jamaica, who all declared that they had all their own peculiar flavors. On the 3d of September, 1881, another box was sent me from Jamaica, containing sugar-cane, guavas, fresh ginger, and turtle; the turtle had come to grief, because it was not properly treated on the other side; the cane, guavas, and fresh ginger have been tasted by those who have lived in Jamaica, and have been pronounced to have their true flavors.

Ordinary milk cannot be kept good for a long time, especially in hot weather. If milk were concentrated in this country, and heated with the boroglyceride, carriage would be saved, and the milk might be kept good and fresh for a fortnight and more; all it would require would be to reduce it again to its original strength. If fresh milk be treated with this preservative it can be set for cream for several days, even in hot weather. The cream which rises will keep, and the skim milk will remain sweet for several weeks; this I have tried in the dairy at Beaumont College. From the cream so prepared butter was made, and was kept for several weeks without a particle of salt, and was eaten by members of the college. I also wish to show another method by which meat can be preserved and cheaply transported. In South America, about Buenos Ayres and the River Plate, many cattle are killed simply for the hides and fat; the flesh is thrown away. Now, if this flesh were cut up in small pieces, and put into the preserving liquid for a night, it would, even in that hot climate, keep good for some time. It could then in a few hours be dried in the sun, packed in casks, and sent to this or to other countries. I have a specimen of beef treated in this way. It was put into the solution on January 19, 1882, dried February 1, and has lately, within a few days, been boiled, and here is the resulting beef tea, which has not in any way been flavored. I have also small quantities of beef juice here preserved in bottles. The juice was expressed, and has been kept raw. Raw beef and mutton juice is recommended by medical men in many conditions of the digestive system. I administered it to a near relation for six weeks, and the juice was preserved good by my material; in the case referred to the effect was very satisfactory. It appears to me to be a most important matter that soup meat, and meat for potting and stewing, should be sent to this country in the way I propose. The supply would be large, the prices low, and the profits highly satisfactory, and it would greatly relieve the meat market, because a very large quantity of fresh meat, which is now used for soup, could be employed in other ways. It has been remarked to me: "But would you get people to use it?" I think, to begin with, that if proprietors of hotels and heads of large public institutions, workhouses, and hospitals, could be shown that for half the cost they could have equally good soup and soup stock, they would willingly use it, and from thence it would come into private use. I have specimens to show the effect of boroglyceride on fish. Here are sprats which have been kept for a year; they are dry, but perfectly good and eatable; also some preserved fresh since January 13, 1882. You will be able to judge of their appearance and flavor. I have also herrings and a piece of skate, which have been preserved for the same time. If fishmongers had a tank of this solution, they could, at the end of the day, put their fish in it, and take it out when required. Bloaters, when lightly cured in hot weather, do not keep good many days; if a small quantity of this stuff was used with the salt, they would keep good for months. The same may be said of smoked salmon. That which is very salt costs 9d. per lb., but the mild cured kinds cost 3s. 6d. to 4s. per lb. All could be mildly cured if this material was used with the other curing substances. As an adjunct in curing mild hams and bacon, it would be of great use, for these, when cured lightly, would not go bad, as they often do in the summer time. What I have said as to the temporary preservation of fish by fishmongers applies equally to the preservation of meat and fowls by butchers and poulterers.

It is justly complained of, that the Australian cooked meat is over-cooked. If it were for a short time dropped in this preservative solution, it would keep perfectly well after being lightly cooked, even under-done. I have a piece of beef which was dipped on the 28th February, and boiled on March 9; it has been left in its own liquid, it was not flavored, and no salt was added. Here, too, is a vast field for the application of the process. Here is also lobster, which was taken out of the shell February 1, and here are two lobsters in their shell, which were immersed on the same day.

I now wish to draw your attention to a parcel from Jamaica, which has just arrived, and from which I am able, I am happy to say, to show you specimens which must be of interest. In a jar on the table is some fresh turtle, which I had simply cooked. I thought it better so to present it to you rather than raw. There is also a Jamaica pigeon, also just cooked here, and a *vol au vent*, which I have had made from oysters, which were sent open in the preserving stuff from Jamaica. These specimens will prove conclusively that food sent from a tropical climate retains it freshness and delicate flavor. I have reserved one of the pigeons raw, that you may see in what state it arrived. Some mutton was shipped to me from the Falkland Islands, at the beginning of last August; a piece of it is uncooked on the table. I have also had a piece stewed, which you will be able to taste; this has, of course, passed the tropics. Through the kindness of my friend, Mr. Haffenden, of the "Andaluzia," in the Strand, who owns vineyards in the southwest of Spain, I can show you some perfectly fresh sardines, which he had placed in the preserving fluid several months ago in Spain, and which he brought with him. You will yourselves judge of their condition; I will only remark that they have the peculiar fragrance of that delicate fish, and will it not be a boon to have a supply of this fresh delicacy at a moderate cost?

You will also see, and I hope taste, a pigeon pie. The pigeons and the steak have been preserved raw in stoppered bottles since the 21st of last November, and the eggs since the 4th of July, 1881. I will also call your attention to a tongue, which I myself placed in the solution, February 9, in this year, with some garlic, sugar, and juniper berries, my object being to show that salt can, if desired, be dispensed with. You will, doubtless, find that it will require salt; but you will readily infer that hams, tongues, etc., can be made just as salt as one pleases, and will yet keep perfectly sweet, in fact sounder, than those cured only with salt. This tongue was boiled out of pickle. I exhibit two shoulders of mutton, one cooked, the other raw; they are from sheep killed January 10, 1882. Also a piece of beef preserved on the same day; this, when you have inspected it, shall be cut in slices and broiled. You will see some sausages, both cooked and uncooked; they were made for me by Mr. Bowron, poulterer, of Paddington, early in July last, before I went to Carlsbad. I took some with me to that place, and they were there eaten and pronounced good. These are some of the same lot; they were made as follows: The meat was chopped, put into the preserving fluid for one night, and then mixed with the other material in the ordinary way. They have been kept since in an earthenware jar; they have, therefore, been made more than nine months. I may remark that the bread in these sausages was not treated, and, therefore, it has become slightly sour, but the pork has kept perfectly fresh. I have also some other sausages, which I bought January 12, and at once preserved; these having been steeped, the bread has not turned in the slightest degree sour.

Mock turtle soup, bought ready made from a confectioner's shop in Oxford Street, January 25, treated with the preservative stuff, has remained quite good, and unchanged in flavor.

There is also a specimen of gravy soup made in October last, and some vermicelli soup made about three weeks ago. The preservative action of the boroglyceride in cooked foods is, it seems to me, of great importance to hotel keepers, confectioners, and restaurant proprietors, as it will enable them to buy large stocks when certain articles are cheap, and from the specimen I show of cooked beef, you see it remains quite moist, as it can be kept, without getting sour, in its own gravy and under a layer of its own solid fat. To prove that articles can be kept and dried without losing their flavor, I had some patridges treated and dried last February twelvemonth, and I exhibit some soup made from two of these birds. The other articles on the table are, one raw and one roast fowl, bought January 17; one raw and one roast pheasant, bought February 5; one rabbit boiled, bought January 17. There are also from Jamaica, a green lime, some fresh tamarinds, and some pieces of fresh ginger.

You will notice on the table frying-pans, etc., and some of you will, doubtless, remember the time when I had the honor in this room of introducing to your notice a process for the prevention of rust on iron. I had intended using them this evening, and for the nonce turning cook before you, but Mr. Wood kindly suggested that the housekeeper should do the cooking below, so as to save you from the unpleasant smell of mixed odors. These cooking utensils have been all treated by what is now called the Bower-Barff process, and as you will pardon a little vanity in me, I feel sure I may sing the praises of my child, now that in abler hands than mine, he has been reared and rendered fit for introduction to the public. I have used such cooking vessels ever since I read my paper; they are better and far cheaper than those made of copper. White sugar can be boiled in them for preserving crystallized fruits without the slightest discoloration.

But before concluding, I wish to state that I have made experiments on the effect of the boroglyceride on fermentation, but they are not yet brought to a complete issue. When added to a fermentative mixture, it prevents fermentation, when added after fermentation has begun, it does not stop it, it only moderates it. A gentleman, Mr McNisch, of St. Neot's, Hunts, largely engaged in the export beer trade, tells me it so far does not interfere, with the condition of bottled beer; he requires a longer time to test its preservative powers. A year ago, my friend, the Rev. Mr. Dobson, tried experiments with beer; he will tell you the results of them. As to cost, I can assert that it will not materially affect the price of the articles preserved. I thank you, ladies and gentlemen, for the patient hearing you have given me.

DISCUSSION.

The Chairman said the paper was marked by the clear and philosophic way in which the subject was treated, and before inviting discussion upon it, he would mention shortly his own experience of the process, the only interest of which was that it was quite independent of Professor Barff. When he was asked to take the chair, he communicated with Mr. Barff, and inquired what the process was. Mr. Barff kindly sent him a specimen of this substance, which he melted, and put some of it into one half of a pint of cream. The other half very soon turned sour, and had to be thrown away, but that to which the substance was added was perfectly fresh that morning. He was confirmed in the opinion of its freshness by the cook, though she said there was a very slight tartness perceptible, by which she could distinguish it from fresh cream. He had also tried another experiment on meat which was chopped very fine, and divided into two parts; to one part he added merely tepid water, to the other, tepid water to which one-sixteenth of its bulk of this compound had been added. This was left on the meat for 18 hours, and then filtered off through muslin. Several days ago the portion which had no preservative was very offensive, but the other portion was that morning perfectly free from any odor whatever.

The Rev. J. L. Dobson said he had had the pleasure of being associated with Mr. Barff in most of the experiments he had detailed, and might therefore anticipate his reply to one or two points raised by Dr. Graham. An experiment which was tried for some time in a large school would answer the question of wholesomeness. At the Beaumont College, Windsor, there was a large staff of teachers, and over 200 pupils, and during the hot weather of last summer the dairymaid was very much annoyed at the milk turning sour, and applied to him to see if he could do anything to counteract it. He handed her some 14 or 15 lb. of this material, and during the whole of the hot weather, and well on into September, it was constantly used, and the milk was preserved; but the method was not detected by any one, either by the younger members, or by those who might be expected to be more critical. No ill effects were observed by the medical officer, or by individuals. From his own experience, he thought the aroma was very well preserved throughout. For instance, in oysters which had been preserved over three months, there was the characteristic aroma of the fresh oyster; mutton could be easily distinguished from beef, and the peculiar smell of the turtle was also very distinct. They had not yet tried beer with so much fullness as other articles, but about nine months ago, a small quantity was treated, and left exposed to the air, with only a loose stopper of cotton wool. It did not grow cloudy in the ordinary way, but owing to the severity of the experiment, and perhaps to not sufficiently treating it, after four months it lost all flavor, became extremely flat, and a slight fungus appeared.

Dr. Thudichum had listened with great pleasure to the paper, and had no doubt if the application of the invention could be effected on a large scale, it would be very useful. He had some experience with regard to a portion of the ingredients used, viz., boracic acid, though he had none of this beautiful new compound. It might not be known to the meeting that boracic acid had been used for a great many years for preserving food, and in fact many of them in summer time had their milk well dosed with it. It had been sold to milkmen in London for years under the name of "aseptin." He had tested it in 1865, and found a great many of those effects which Mr. Barff described. For instance, eggs were beautifully preserved, and steak immersed in the solution did not become either mouldy or rotten, but on the contrary appeared to retain its flavor. A variety of other things, such as cheese and cream, were, either for a long time or for ever, preserved by this application of aseptin. He hoped the addition of the glycerine would increase the power, and prevent some drawbacks which would otherwise stand in the way of boracic acid alone as a preservative of raw or cooked meat.

Mr. Liggins said it was his duty, for many years of his life, to see that the ships of his father and himself were properly victualed for voyages of from three to five months, and he had, therefore, some experience in meat. In his opinion the viands before them, both cooked and uncooked, were in an admirable state as far as the eye could judge. From the description given, he should think any one could use this process without any scientific apparatus, and, therefore, it was a matter of general utility. He had often, when in the West Indies, enjoyed the preserved products of this country and the United States, and had eaten many good joints of meat which had been six weeks at sea; they were preserved in ice—not frozen—and retained their flavor very well. He was not surprised, therefore, at another process, which was capable of bringing things from Jamaica, particularly the fruits. He did not see why there should be any comparison drawn between salt meat and this, though his experience did not quite agree with Alderman Selwyn's; he believed sailors in the merchant navy would be very much offended if their salt meat were withdrawn. He was aware, from reading Cook's and Anson's voyages, that scurvy was once the great scourge of the merchant navy, but there were reasons for that which no longer existed; the voyages were not so long, medical science had very much advanced, and matters of diet were much better understood. He had seen many a turtle killed in the West India islands, and it had to be cooked within an hour. It would be a great saving if what was not immediately required could be preserved for future use, instead of being thrown away. The same with meat; it was the custom there, before an ox was killed, to arrange who should take the different joints, but if those not required immediately could be preserved, it would be a great saving to housekeepers and a convenience as well.

Professor Barff, in reply to the various questions which had been asked, said he had used salicylic acid, and had found it useful in preserving food, but for several reasons discontinued further investigations, one being on the score of its wholesomeness, and he found that his views on that point had been borne out by the action taken by the French Government. Dr. Graham had asked him about flavor; he had given Dr. Graham, a few days ago, some specimens of preserved fish, which he said had lost their flavor, but that would not be found to be the case with the box of sardines. The herrings had been kept in an open vessel, exposed to the air, ever since the day they were put into the liquid, and, therefore, it was not surprising that they had lost their flavor. If they would try any of the things which had been tinned, not soldered up, but such as the Jamaica pigeons, which were in a common corked bottle, it would be found that the aroma and flavor were retained. The only thing

requisite was to keep the vessel so as to exclude the air, as you would with tea or coffee. Dr. Thudichum made some very interesting remarks which there was not time to refer to at length, if he were competent to do so, but not being a medical man, he could not enter into medical questions. As to the wholesomeness of the compound, however, he might say that he had taken large quantities of it himself, and it had never done him any harm; and a near relative had taken an ounce per week regularly for a year and a half, without any ill effect—a person, too, not very strong or of good digestive powers. The boys and teachers of Beaumont College drank milk preserved with it without distinguishing the taste or suffering any ill effects. He knew there were medical opinions in favor of boracic acid, and one physician he was acquainted with used it as a medicine. If it were at all unwholesome, he certainly should not recommend it, but he did not think there was the slightest fear. As to boron getting into the system, it was not boron which was used, but oxide of boron; but even if it did, and he should not be surprised if traces of boron were found in the excreta, it did not follow that any harm was done. There were many things which went through the system without injury; for instance, silica, of which most people took a great deal in the twenty-four hours. As to the cost of the process, the cost per gallon, as far as he could tell—he could not say exactly—would be under 1s.—perhaps 8d. or 9d.—and a gallon would affect an enormous quantity. Most of the articles on the table were put into one pan of solution and the cost of the whole stuff was about 9½d. Should the process be adopted commercially, experiments as to the cost would be most carefully made, and the results published. A joint of any size could be soaked; the only thing was to give it plenty of time. You might soak a piece of beef of twenty pounds, forty pounds, or fifty pounds; or you might use an injecting syringe, such as butchers employed for salting meat quickly, and the meat so treated would keep for a week or a fortnight perfectly good, but he did not think it would keep well enough to pass under a tropical sun. In order to do that you must inject by the aorta, by means of a force pump, so as to send the liquid into all the interstices of the flesh. As to the proportions, one in twenty was the strongest he used, and one in sixty the weakest; for preserving meat, one in fifty answered perfectly well—one pound of the compound added to fifty pounds of water. The bottle should be put before the fire until melted, and then poured into hot water, and it would dissolve. With regard to preserving morbid specimens, he thought it would answer perfectly well. He had had some practice in morbid anatomy, and he might say that, for the injection of bodies to be used for anatomical purposes, it would keep them perfectly sweet. It should be injected by the aorta in the usual way before injecting with the red wax. In reply to Mr. Dipnall he would say that compound penetrated right through into the innermost parts of the meat. If you had an earthen pan and put into it one pound of this and fifty pounds of water, and placed in it a joist which came home on the Saturday night in hot weather, you could take it out the next day and it would keep perfectly for a fortnight. Of course it took time to penetrate into the meat, but the first superficial penetration stopped the injurious effects of germs which set up putrefaction. Another important fact was this: if you had a roast leg of lamb, perfectly good, but did not eat it all, and put it away in hot weather, it would turn sour, but if it had been treated in this way it would not; it would keep for six months without going sour. By adding a small quantity from time to time, which you could only learn by experience, the bath would keep perfectly fresh and effective, though it would be found after a time to get rather dark colored. That arose from the juice of meat, and the advantage of this process was that you need not throw it away, as you must brine, but could boil it down into very good soup. In conclusion, he would only ask his hearers to read the paper and discussion carefully when published, and he was sure any one would be able to carry out the process.

The Chairman, in proposing a hearty vote of thanks to Professor Barff, said the process he had described was remarkable for its great simplicity, and the ease with which it could be carried out. Any cook could readily apply it.

The vote of thanks was carried unanimously.

SULPHUR IN PYRITES.

By F. BŒCKMANN.

THE methods of Lunge and Fresenius have afforded a satisfactorily accurate and expeditious means of determining the sulphur in pyrites. As a third process, which also gives good results, I recommend the following modification of the potassium chlorate method: Half a grm. of finely ground pyrites (sifting is not absolutely necessary) are mixed in a large platinum capsule with the well-known mixture of six parts sodium carbonate, and one part potassium chlorate. The mixing is effected with a platinum spatula, and is then made more complete by gentle rubbing with an agate pestle fixed to a wooden handle. The whole is then fused over the blast-lamp. The aqueous solution of the melt is first poured into a beaker to avoid spirting, and thence into another tall beaker containing an excess of hydrochloric acid. The filtered solution is heated and precipitated with hot barium chloride, heated gently upon the sand-bath for a time until the liquid standing above the precipitate has become clear, and is filtered at once. The burnt ores in sulphuric acid works have been for a long time assayed for sulphur by this process. I take about two grms. of burnt ore to from 20 to 25 grms. of chlorate mixture.—*Zeitschrift für Analyt. Chemie.*

NEW METHOD FOR DETERMINING THE GYPSUM CONTAINED IN WINES.

By M. E. HOUDARD.

I SUBMIT to the Chemical Society of Paris a method which has rendered me substantial services for more than a year, for determining, in a quick and easy manner and with a sufficient approximation, the proportion of potassium sulphate, or rather the corresponding quantity of sulphuric acid, found in almost all Mediterranean wines from the "plastering" carried on by the growers.

This method does not offer much interest from a scientific point of view, but it may prove important for all those who are concerned with the analysis of wines of ordinary consumption. It is based upon the formulæ of M. Poggiale, modified in 1876 by M. Marty, Professor at Val de Grace, but in place of indicating merely if a wine contains more or less than two grms. potassium sulphate per liter, it enables us to determine the proportion to about one-half a grm. per liter; its chief merit is that, unlike the methods at present employed in laboratories, it is within the reach of all.

The process requires ten test-tubes placed in two parallel rows, five in each row; a pipette of 25 c. c., graduated in five divisions, each of 5 c. c.; a burette graduated in five divisions, from 0·5 to 2·5 c. c., each division consequently containing 0·5 c. c.

It being known that 10 c. c. of M. Marty's standard liquid precipitates 0·1 grm. potassium sulphate per liter, we begin by pouring into each of the test tubes of the first row 5 c. c. of the wine in question. We then add to each of these tubes, by means of the burette, Marty's standard liquid, pouring into the first tube 0·5 c. c., into the second 1·0, and so on till the fifth tube receives 2·5 c. c. The contents of the five tubes are heated and filtered respectively into the five tubes of the second rank. It is then merely needful to add a drop of the standard liquid to each of the second set of tubes, and to note in which tube it produces a faint turbidity. If, *e. g.*, this turbidity appears in No. 2, and not in No. 3, it appears that the wine contains more than two grms. per liter of potassium sulphate, and less than three grms. Hence it may be concluded that the proportion is about 2·5 grms. per liter.—*Bulletin de la Soc. Chimique de Paris.*

LABORATORY APPARATUS.

Desiccating Case.—On taking them from the stores, the different vessels and capsules containing matters to be weighed cannot be put directly on the scales; they must

FIG. 1.—DESICCATING CASE.

first be allowed to cool in dry air. For this purpose they are put into a desiccating case. This is a sort of small glazed cupboard, carefully closed, and divided into two equal parts. In each of the latter is placed a porcelain vessel filled with pumice stone, saturated with sulphuric acid. The capsules are placed on a metallic plate pierced with holes, or on glass shelving. The doors of the case are lined with small bands of rubber, thus rendering them as hermetical as possible.

Apparatus for the Extraction and Quantitative Analysis of Gases.—The apparatus shown in Fig. 2 has been used for extracting and analyzing the gases contained in sewer mud, but may also be employed for extracting gases from other substances, such as blood, etc.

The most important part of this apparatus is that placed to the left in the figure, and consists of a receptacle divided into two portions by means of a cock with a wide opening. The lower part is cylindrical, and is closed perfectly by means of a rubber stopper. The upper part, which contains three inflations, is surmounted with a funnel whose tube extends to the lower sphere instead of ending in the second, as represented in the figure.

The uppermost sphere or inflation communicates laterally

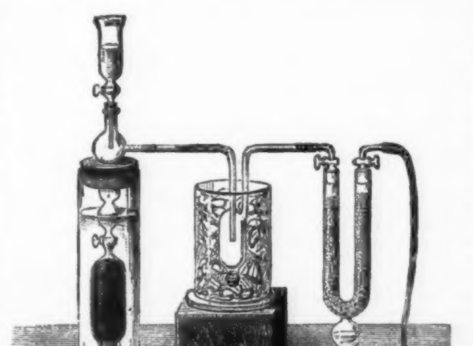


FIG. 2.—APPARATUS FOR EXTRACTING GASES.

with a cooling receptacle, then with a U-shaped tube filled with small glass balls, moistened with concentrated sulphuric acid. This U-shaped tube itself communicates with an Alvergniat mercurial pump, by means of which a vacuum may be formed and the disengaged gases collected.

When it is desired to introduce mud into the apparatus, the receptacle is inverted, the middle cock is closed, the rubber stopper is removed, and the cylinder is filled full of the material. It is then corked up, and the whole is arranged as shown in the cut. Care is taken to grease the external surface of the funnel tube, so that the bubbles of gas disengaged from the mud may burst in the inflated tube. The cocks of the mud receptacle being always closed, the vacuum is formed in such a way as to remove the air from the inflated tube, from the refrigerant, and from the U-shaped tube. Such a result being effected, the cock above the mud is opened. The gases from the latter are then disengaged, and are collected by means of the Alvergniat pump.

Through the funnel tube there may be introduced a diluted acid for attacking carbonates and sulphides.

CÆSIUM.

ONE of the first fruits of spectrum analysis was the discovery of the two alkaline metals cæsium and rubidium, by Bunsen and Kirchhoff. The salts of these metals were closely examined, and found to show a similarity with the compounds of potassium more complete than had yet been observed among analogous bodies. The two metals are the most electro-positive of all known substances, and form consequently the ultimate members of the electro-chemical series, being more positive even than potassium. With this property is naturally combined an exceptional affinity for oxygen, which, especially in the case of cæsium, is so great that the isolation of the metal was found impossible, and the discoverers, being unable to separate it from the accompanying non-metals, had to content themselves with the examination of its compounds. Rubidium, however, was isolated by Bunsen, and was described as a light metal deceptively similar to potassium, but much more fusible.

Carl Setterberg has lately effected the isolation of cæsium. His method was the electrolysis of a fused mixture of cæsium and barium cyanides. Having relatively enormous quantities of the precious materials at command—by means of a process of his own invention he has prepared 40 kilos rubidium, and 10 kilos cæsium-alum—he has produced cæsium as a metal very similar to the remaining alkali-metals, silver-white, very soft and ductile. Its melting-point is 26·5°, and its sp. gr. 1·88. On exposure to the air it ignites spontaneously, and if thrown upon water it burns like potassium, sodium, and rubidium. Setterberg has proved anew that in consequence of the affinity of the metal for oxygen, and the volatility of its salts, the preparation of cæsium by igniting its carbonate along with carbon—according to the ordinary method for obtaining rubidium and potassium—is quite impossible.—*Annalen der Chemie und Pharmacie.*

ORGANIC CHEMISTRY.

THIS name was derived from the fact that at one time all these complex bodies were presumed either to occur in the structures of plants or animals, or to be immediately derived from such. Plants and animals consist of certain organs—that is, instruments or apparatus in connection with which alone life is manifested—and the study of organic chemistry was presumed to relate solely to the bodies forming these organs or to the products yielded by them. Organic chemistry, according to this original view, was the chemistry of vital processes, and any compound, produced directly or indirectly by vital action, was studied under this head. Thus starch, cellulose, sugar, albumen, oil, etc., are complex substances, produced and deposited in the tissues of plants, and other bodies of a similar nature are also found in animal tissues. Then again, the products of the chemical transformation of such substances as we have enumerated belong to the domain of organic chemistry; in this way alcohol is a substance correctly described as organic, for although we are not acquainted with any plant or animal which directly produces alcohol within its tissues, we know that it is a product of the fermentation of sugar, and therefore it is classed among organic compounds. In like manner acetic acid is not found in plants or vegetables, but being produced by the oxidation of alcohol, it is derived directly from organized matter, and is therefore classed as organic. So also with ethers and aromatic bodies, which are derived from organic substances, and we might multiply examples to an indefinite extent. Although no strict line can be drawn between inorganic and organic substances, the distinction is a convenient one, and is sufficiently marked to justify the classification. By many chemists, organic chemistry is defined as the chemistry of the carbon compounds, because it relates solely to bodies containing carbon, that element being an essential constituent of all organized matter, and of all bodies derived from such; this predominance of carbon in organic substances makes them combustible, and therefore organic matter has also been defined as that which is charred and destroyed by heat; but this definition is not a very correct one, as we are now acquainted with many substances undoubtedly of organic origin, which are not charred, or even decomposed, by any reasonable heat. Although organic substances are so much more numerous, and far more complex than inorganic substances, it must be clearly borne in mind that they are subject to precisely the same laws, and are built up and transformed by the same influences which affect inorganic bodies. In addition to carbon, which is the essential element, oxygen, hydrogen, and nitrogen, and occasionally sulphur and phosphorus, enter into the composition of organic substances, and we also often find certain mineral substances allied with organic compounds, especially in such as are directly derived from plants and animals; these mineral constituents are left behind when an organic substance is submitted to prolonged ignition, and they constitute what is called the *ash*.

Isomerism.—This term, which is derived from two Greek words, signifying "equal" and "part," is applied to a phenomenon which is repeatedly observed in the study of organic chemistry. Substances are said to be isomeric when they possess the same percentage composition, but differ in their chemical and physical properties. Organic chemistry abounds with such examples; thus taking cellulose, starch, and dextrine, three substances met with in grain, and known to every brewer, it will be seen by the following table that they possess the same percentage composition, but, as will be pointed out in greater detail, when each substance is fully studied, they differ materially in chemical and physical properties:

	Cellulose.	Starch.	Dextrine.
Symbol.......	$C_{12}H_{20}O_{10}$	$C_{12}H_{20}O_{10}$	$C_{12}H_{20}O_{10}$
Percentage of carbon.....	44·4	44·4	44·4
Percentage of hydrogen ..	6·2	6·2	6·2
Percentage of oxygen	49·4	49 4	49·4
	100·0	100·0	100·0

Cellulose, starch, and dextrine differ from each other; the first-named is completely insoluble in water, the second is only soluble at high temperatures; and the third is completely soluble in the cold. Again, each of these substances gives a different reaction with iodine, and their general appearance and physical properties also greatly differ. The chemist attempts to explain this remarkable phenomenon by assuming that the individual elements in isomeric compound-

are arranged in different ways. Thus, taking the three substances we have just used as an illustration, we may assume that the atoms of carbon, hydrogen, and oxygen in each are arranged altogether differently, and thus compounds are obtained which possess different properties. Isomerism has been forcibly compared to an anagram; thus, taking the words *tar*, *art*, and *rat*, which are all made up of the same letters, we find that by varying their respective positions the three letters *a*, *r*, and *t* form words possessing different sounds and differing greatly in meaning. Cellulose, starch, and dextrine are also made up of carbon, hydrogen, and oxygen; but by arranging these elements differently, three distinct compounds are formed, varying as much in their way as do the words derived from the anagrammatic arrangement of the letters *a*, *r*, and *t*. We might introduce numerous examples of isomerism which abound in the study of organic chemistry, but, in addition to the series given above, we will, at the present time, content ourselves with referring to the saccharine series, comprising:

Cane sugar	$C_{12}H_{22}O_{11}$
Maltose	$C_{12}H_{22}O_{11}$
Milk sugar	$C_{12}H_{22}O_{11}$

all of which have the same percentage composition, but differing materially in chemical and physical properties. We may also mention the essential oil series, which includes a very large number of volatile oils possessing characteristic and easily distinguished odors, but which all contain a hydrocarbon of the formula $C_{20}H_{16}$.—*Brewers' Guardian.*

SALICYLIC ACID.

LATEST RESULTS OBTAINED BY THE USE OF SALICYLIC ACID IN BREWING.

For preventing beer from turning sour the brewing industry has at its disposal various means and methods, but the apparent cheapness of some of them is, of course, no criterion of their real merit in the end. Acidity may, it is true, be averted by some such means, but they are admitted to possess many drawbacks as regards the wholesomeness, the taste, the flavor, etc., of the beverage, for instance, the stenchy flavor noticeable in many large quantities of beer, especially in summer, or after a long sea voyage, with the absolute exception of beer which has been preserved with salicylic acid only.

Salicylic acid is a white crystalline powder, perfectly devoid of odor. Its solution in water is colorless, and, on dilution, is quite free from taste. Hence, neither the color nor the taste of the beer preserved with the said powder will be altered in any way. It never causes any odor, nor does it impart any flavor to the liquid preserved, or alter the natural flavor of the beer. In cold beer the powder dissolves within a few days, and in hot worts almost immediately. Salicylic acid is no substitute for any ingredient essential to the constitution of beer, nor does it improve bad or spoiled beer—it is simply a preservative agent. The addition of certain proportions of it to the beer has the effect of entirely preventing the production of acidity (in the form of lactic, butyric, and acetic fermentation), and also of turbidity from organic impurities, rendering impossible the development of such parasites of the yeast and the beer, without having any deleterious influence whatever on the yeast itself, or on the sound condition of the beer; provided that the proper quantities be used.

Any material excess in the addition to the worts might paralyze the yeast. Any material excess in the addition to the finished beer might retard the still alcoholic fermentation.

A rational use of salicylic acid in brewing does not intercept the attenuation; it gives the beer a prolonged immunity from false ferments, permits the steady and normal development of the taste and flavor, and frees it from any risk of becoming sour or stenchy.

Professor Blas, of the University of Louvain, has declared, before the Royal Academy of Medicine of Belgium, that he prefers a salicylated beer to any other of the same make not salicylated, because, as he states, it keeps better, and is, therefore, more wholesome.

For the finest descriptions of ale and stout, half an ounce of the powder to every barrel (36 imperial gallons) of finished beer will be found quite sufficient for the aforesaid purposes.

As much as three quarters of an ounce per barrel (36 gallons) is suitable for porter and stout made for export; the more common kinds of porter and ale may require up to one ounce per barrel, if they are to be kept for a long time in stock, or sent out on a voyage, especially in hot weather or hot climates.

The addition of salicylic acid to the finished beer should be effected when the liquid has just left the fermenting vats.

Ascertain, by weight, the proportion requisite for each barrel (for which purpose a measure in the shape of a wooden goblet or small scoop may conveniently be adopted for permanent use), and drop it into the cask recently filled, whereupon the latter is closed with the bung, as usual, and rolled over a few times. This is the whole operation, and any steady workman, once properly taught, can perform it in an exceedingly short space of time.

The following are given as directions for the occasional use of salicylic acid for the purification of yeast, and the regulation of the fermentation process. In cases where the yeast is somewhat infested with other microscopic organisms (false ferments), or where circumstances give rise to the apprehension of their turning up in the fermentation itself, it will always be advisable to resort to a trifling dose of salicylic acid, in order to suppress such parasites.

Experience has taught us that—a quarter of an ounce of salicylic acid per barrel of boiling worts not only destroys the false ferments, but also makes the yeast crampy; on the other hand the reduced dose of one drachm per barrel (36 gallons) of boiling worts (or a quarter of an ounce for every four barrels) answers the first-named purpose, that is: it keeps the yeast pure and clean without detriment to it, and also has the collateral effect of slightly moderating the speed of the fermentation process, which is, in fact, a recognized advantage, improving the final quality of the beer.

Thus, the addition of the said minute proportion of salicylic acid powder to the worts while still hot, subsequent to boiling with the hops, has been proved to be a valuable ally to the cooling worm (of the fermentation vats), enhancing its effects, and enabling it to act with the desirable accuracy. A liberal use of mother-yeast will, with the treatment above described, entail a satisfactory yield of fine robust white yeast. The salicylic acid applied to the worts is entirely absorbed during the fermentation, therefore its weight is not to be deducted from the proportion required to preserve the finished beer.

ON THE RELATION OF VEGETATION TO THE INDUSTRIAL ARTS.

By Prof. August Vogel, of Munich.

A naturalist of the olden times called plants "true friends of man." When we contemplate the endless importance of the plant as food for animals, and take into consideration their manifold uses as remedial agents, the above assertion seems to be justified. But in other directions the influence of living vegetation upon the "weal and woe of mankind" is no less important. It is not merely the finished products—the infinite army of dyestuffs, the fatty and ethereal oils—which plants give us as such, which render them indispensable to us, but the changes which attend plant activity, both on and under the earth, are of the very greatest importance to us.

First of all, we must consider that there dwells within the plant—that beautiful creation of air and water—a chemical force of very uncommon energy. The plants in their quiet household carry out, with the simplest aids, that which we in our laboratories can only accomplish by the greatest exertion and care.

To adduce a single example, we may mention the decomposition of carbonic acid by green leaves with the aid of sunlight. It is the plants which preserve the equilibrium of the atmosphere by decomposing the carbonic acid formed by respiration and combustion, and set free the oxygen needed for breathing. Hence we see that the designation of plants as "true friends of man" is insufficient; we must add that they are our indispensable allies, without which human life were inconceivable.

Carbonic acid is a very intimate compound of oxygen and carbon; in it the carbon and oxygen are fettered together by bands very difficult to rend asunder. We require a high temperature and powerful reducing agents to split this union. The green of the leaf seems to accomplish this difficult task without special trouble, by the aid of sunlight.

If we say that chlorophyl accomplishes this analysis, this is not accurately correct. If this were the case, then chlorophyl separated from vitality should produce the same effect. We can extract the chlorophyl from the green parts of plants by means of ether and other solvents. If, now, this substance of itself possessed the power of decomposing carbonic acid, the coloring matter thus separated must also possess that power; but this is not the case. If we allow a ray of sunlight to fall upon a solution of chlorophyl floating upon aqueous carbonic acid, no effect is produced. Nay, if we merely crush a green leaf—that is, destroy its vitality and its structure—the coloring matter thus torn away from its living tissues loses its power of decomposing carbonic acid. I mention this merely in support of the recognized fact that this energetic chemical action belongs exclusively to the phenomena of life in plants.

In the growth of plants we everywhere meet with numerous chemical reactions; the plant likes to be chemically active; it decomposes carbonic acid and ammonia, it forms nitric acid from the nitrogen and oxygen of the atmosphere, then decomposes it again, and so on. Even the absorption of mineral constituents, through its roots, from the soil, is by no means purely mechanical. We know from Liebig's researches that every root secretes acids—whether there is any other acid formed beside carbonic acid, which is always present at any rate, may remain undecided—and these aid essentially in the absorption of mineral constituents from the soil.

"Plants attack the soil with the secretions from their roots." (Liebig.) If bright, polished plates of rock crystals, quartz, or flint are buried in the soil, so that the roots embrace them, after a time the spots touched by the roots become dull, showing that these minerals are attacked by the roots. This action of roots is more distinctly seen on limestone. In fields where cereals have been cultivated many years in succession we frequently find crevices in the stones due to the action of the roots.

This chemical activity of plants beneath the ground, which here interests us most, may be considered as a powerful technical lever. Plants play an important part in the preparation of materials, both useful and of great technical importance, as, for instance, in the manufacture of soda and potash, and the preparation of iodine and bromine. Runge says very aptly: "The plant is a great chemist; it is frequently able to distinguish and separate substances more definitely and accurately than man can with his chemical reagents."

We know that where a soil contains lime, clay, silica, iron, magnesia, potash, soda, etc., different plants will take up very different elements. *Lycopodium complanatum* (earth-moss, or club-moss) will take up chiefly alumina, which is not accessible to other plants because of its insolubility in carbonic acid. Grasses and horsetail are able to take up an unusully large quantity of silica. Wormwood (*Absynthium vulgare*) prefers to attack the potash, *Glaux maritima* prefers soda, the Hortensiæ take the iron, while a great number of plants—we can almost say all of them—take lime. We may here touch upon the much-debated question, whether plants possess the power of selection in their absorption of mineral food from the soil. Without, of course, wishing to fully discuss a question which has caused so much controversy, I should like to cite a few examples that may perhaps aid in settling the question. First, it is a fact that in different plants there are found different quantities of the single constituents, even when they grow upon the same soil, or on that of the same chemical composition. If we sow lime plants and potash plants on a fertile soil, containing plenty of both, the one will take up lime, the other potash. Upon this, as we know, depends the alternation of crops. If a soil has been robbed of a greater part of its potash by one kind of crop, a good harvest of some lime crop can be raised on it the following year, and *vice versa*. This is, with some show of reason, attributed to the power of selection in plants; they select from the soil the food which suits them. But then, of course, there is a weighty objection raised. If the uninjured roots of two plants are placed in two salt solutions—for instance, chloride of barium and of potassium, one of which is inimical to vegetation, the other conducive thereto—*both* salts will be found in their ashes. The absorption of a substance poisonous to them is contrary to the idea of selective power. There is, to be sure, always found a smaller quantity of the inimical salt than of the favorable one. The growth of the roots, as learned by numerous examples, depends on the nature of the soil. It has been observed that in fertile soils, where enough nourishment is found in the immediate neighborhood, the roots are shorter than in sterile soil. The celebrated traveler, Von Martius, relates that the largest trunks in the primeval forest, which are sometimes torn away by the swollen Amazon after the heavy equinoctial storms, have comparatively small roots. This, I think, is due to the fact that in this over-fertile soil it is unnecessary for the roots to go as far in quest of nutriment as in less fruitful ground. It is like the foragers of a victorious army, that must sweep over a larger space to get food when the country has been exhausted than elsewhere. If this is not exactly a proof of the power of selection among plants, it at least shows a voluntary effort to obtain its own food.

Feldspar may be considered as the principal storehouse for all the potash on the earth; but there it is in a very insoluble compound with silica and alumina. Chemists and mineralogists all know how tiresome it is to separate the potash from such compounds, and when we recollect that feldspars contain but 6 to 15 per cent. potash, potash would be to-day a very expensive article if we had to prepare it all from feldspar. Hence it was that for a long time we were ignorant of its presence in many minerals like leucite, orthoclase, porphyry, basalt, etc., and its discovery was due to plants. It had long been noticed that the ashes of all plants contained potash, even those growing on soils supposed to contain none. This puzzling circumstance gave rise to the pardonable supposition that plants produce potash, and, as it was found nowhere else, it was called the vegetable alkali.

It is not only the potash which has been set free from this very stable chemical compound by the destructive power of atmospheric influences alone which supplies the plant, for the roots of the plants aid in decomposing feldspars. The plant roots are able to take up potash from the insoluble compounds in which it occurs in almost all kinds of soils, and to supply us with this valuable material in the ashes as potassium carbonate. The preparation which takes place in the subterranean workshops of the plant renders vegetation an important lever in the technical arts. We let the plants work for us; they undertake for us the troublesome and costly operation of collecting from the rocks the potash that serves to nourish them, and we have only to leach their ashes. As yet all attempts to make potash directly from minerals have proven far too expensive. Technical chemistry is not able to compete with the plant in chemical operations. Until the discovery of the rich potash treasures of Stassfurt, Kalucz, etc., potash could not be made without the intervention of the plant.

The common woods used for heating furnish on the average 0·2 per cent. of potashes. The sugar beet is very rich in potash, and early in the present century, when the beet-sugar industry began to acquire some importance, Dombasle designated the beet as deserving attention in the production of potash salts. He sought to use the beet for making sugar and potash both, and proposed to pull off the leaves near the end of the season and burn them for their ashes. One hundred pounds of dry leaves left ten and a half pounds of ashes, from which five and one-fifth pounds of potash is obtained. It was found, however, that it injured the beet to remove its leaves, so that it was abandoned. It was afterward found that the potash salts were in the juice, and remained in the molasses after separating the sugar. The sugar remaining in it was converted by fermentation into alcohol, and this distilled off, when the dried residue was calcined for potash. This industry has grown to such an extent that one German beet-sugar factory was making, a few years ago, thirty tons of potash annually as a by-product. The potash thus taken from the soil is replaced by the far cheaper Stassfurt fertilizers.

Some time ago it was proposed to use wormwood for the same purpose and to cultivate it. Experience showed that 18,000 square feet of ground would yield three crops in one summer, and make in all 10 tons of dry plants, yielding 24 cwt. of ashes and 1,000 lb. of potash. It will be seen that technology does not despise the aid of vegetation.

In what form potash is present in living plants, what rôle it plays in plant cells, this is at present an unsolved riddle. This much is sure, that in the cells of the plant the potash must be combined with organic substances which, when the plant is burned, are converted into carbonic acid, so that the potash of plants is obtained as carbonate chiefly.

Plants are also efficient in making soda. Those which grow near the sea extract sodium from its chloride, and give it to us in its ashes as carbonate. In Spain a plant called *Salsola* is cultivated by sowing its seed annually on the coast, so as to get its ashes. Formerly it was highly prized in commerce under the name of barilla. It forms solid gray lumps containing from 25 to 30 per cent. of carbonate of soda. In the same way the *Salicornia annua* is cultivated on the French coast of the Mediterranean Sea for its ashes, which contain 14 or 15 per cent. of carbonate of soda. The quantity of soda won in this way is, of course, insignificant as compared with the great soda industry. Nevertheless, the production of soda by plants furnishes us conclusive proof of the energetic chemism of vegetation. The so-called soda lakes of Central Africa, California, etc., indeed, contain carbonate of soda in solution, which has probably been formed by the decomposition of sodium chloride with carbonate of lime. The plants of that region can, of course, take up the carbonate of soda directly, but in sea water the sodium is chiefly present in form of chloride (cooking salt). The plant decomposes this salt, and we find the soda combined in part with organic acids, which, on burning the plant and leaching the ashes, give us carbonate of soda. Here the vital power of the plant decomposes a salt which, by chemical means, requires an expensive and roundabout operation.

If, as already shown, the vegetable activity offers such important and desirable help in making potash and soda, it is to the same force that we are indebted for the *discovery* of certain substances now considered indispensable in the arts. But for the active aid of the vegetable forces we should scarcely have made the valuable acquaintance of that highly-honored pair of sisters, *bromine* and *iodine*. In the history of the discovery of iodine vegetable chemistical force plays the chief part. Iodine is contained in sea water, but in extremely dilute solution. Four million pounds of sea water, it is said, must be evaporated to dryness to get three-fourths of a pound. In this extraordinary dilution human investigation would probably never have succeeded in detecting this important substance, to which photography owes its brilliant existence. Fortunately for us, this hidden but powerful plant-force came to our aid. Just as sulphur and phosphorus appear as necessary constituents of land plants, so is iodine indispensable to sea plants; they eagerly seek for it among the waves, and give it a solid form. The power of attraction for iodine possessed by sea plants is very wonderful.

At an early time the ashes of sea weeds were known as kelp and varec, and used, as already stated, for making soda. The ashes were extracted with water, and the carbonate of soda crystallized out. No use was known for the mother liquor after it ceased to yield any crystals, and it was considered perfectly worthless. On pouring sulphuric acid upon it the iodine escaped as violet vapors. It has been much discussed whether we owe the discovery of iodine to

pure accident or not. It seems impossible at this day to prove whether the acid was poured on it accidentally or intentionally. It is an indication of the difference between the journalists of those times and of ours to note that iodine was first mentioned in the Paris Academy at the meeting of November 29, 1813, two whole years after its discovery. The *Moniteur* of December 2, 1813, which reported the proceedings of the Academy, contains, so far as I know, the earliest printed notice of iodine. There is certainly no doubt that at present a few days would have been sufficient to have obtained for such a discovery a general dissemination through the press.

From what has been said we learn that the unseemly plant structures of the sea undertake the first and most important operation in the preparation of iodine; they save us the tedious and costly operation of concentrating the sea water; they furnish to human industry, in their ashes, free of cost, the most concentrated form of sea water. To form an idea of the saving effected by the plant, it may be stated that the cost of evaporating to dryness enough sea water to make a pound of iodine, with the cheapest fuel and best apparatus, would be at least $1,000. I willingly admit that if we made iodine directly from sea water, without the aid of vegetation, it need not everywhere be evaporated by artificial heat; the manufacture could be undertaken in tropical countries, where the sun's heat can be utilized. Even this requires apparatus, which would raise the present price of iodine considerably.

In addition to iodine, the sea plants also contain bromine, which was detected in the ashes of plants growing in the Mediterranean in 1826. The quantity is exceedingly minute. The action of plants is of less importance here, as it is more profitable to make bromine from the mother liquor of the Stassfurt salts, especially carnallite, tachhydrite, and carinite, than from sea water.

The vegetable world, incessantly working for us in their quiet household, justifies us in the hope that we may still further utilize their forces with reference to the constituents of sea water. May they not, in the future, become a means of obtaining from it the silver which is present in such minute quantities, the existence of which has been proven beyond doubt? Who knows whether there may not be some as yet unnoticed individual of the vegetable kingdom, perhaps even of the animal kingdom, which has long been engaged in extracting this silver and concentrating it within narrow limits? It only remains for us to discover the natural method for the concentration of the argentiferous sea water, and then we should possess in the waves of the ocean an inexhaustible source of the noble metal. In fact, the obtaining of silver from the sea at some future time is not so utterly hopeless as it may perhaps seem. We will not, however, yet carry our hopes so far as the celebrated Fourier, who has confidently expressed his opinion that in the future such changes will gradually take place, through the movement of the earth's axis, that "sea water will become a splendid drink, even better than lemonade, that only useful animals will inhabit the sea, and only the most deliciously-flavored fish, and such sea animals as shall *willingly draw our boats.*" For the present we will be satisfied with the fact, and thankfully acknowledge that the inhabitants of the sea, plants as well as animals, undeniably possess a peculiar power of extracting from the sea single elements which it contains in extremely minute quantities, in the highest state of dilution. Regarding the importance of the animal world for collecting the single substances found in the sea, we may recall the shell-fish. The quantity of lime in the Atlantic Ocean is only the one-tenth of one per cent., and yet this small quantity suffices for the shell-fish to build the houses in which they dwell. The wonderful absorptive power of these animals has in the course of time built up immense heaps of lime shells on the bottom and shores of the sea—deposits which men use for technical purposes; nay, more, these wonderful submarine architects take part in changing the shape of our earth, for whole mountain masses and groups of islands owe their existence to them.

In a similar manner the corals, the so-called flowers of the sea, show their activity. From these we may recognize how ever-busy nature, by setting her skilled collectors at work, is laboring for our interests, even in the depth of the sea.

The examples of vegeto-chemical activity in regard to the numerous products which are of use in the arts and industries could be extended much further. The well-known change of starch into sugar, through the germinating power of barley, a chemical operation which the beer brewer uses with such profit; the change of vegetable acids into sugar during the ripening of fruits—these are vegetable labors which are thankfully recognized as valuable aids.

What has already been adduced will suffice to prove that we possess, in the quiet, unexacting economy of the plant, an active helper instituted by nature, ever active in preparing materials of great value in many branches of industry.

HUMBOLDT.

CAMPHOR.*

By G. F. BIHN.

THE technical literature upon this theme is scant, and the purification of camphor was for a long time regarded as a trade secret. It was customary formerly to designate by the name of camphor a variety of solid volatile substances, derived partly from the animal and partly from the vegetable kingdom, and particularly certain solid substances yielded by many ethereal oils after exposure to air, such as bergamot, oil-camphor, Tonka camphor, etc. Many hydrocarbons in combination with hydrochloric acid, such as the terpen-chlorhydrates, were likewise called camphor, from the similarity of their smell to that of the natural camphor.

All these bodies have, however, received some other designation in modern chemistry, and the name of camphor is at present confined to certain products derived from the vegetable kingdom, and distinguished by their volatility and peculiar aromatic smell. These are: 1st. Japan camphor, which is brought into the market simply under the name of camphor, and is obtained chiefly from China and Japan. Its chemical composition is $C_{10}H_{16}O$. 2d. Borneo camphor (composition $C_{10}H_{18}O$) is obtained chiefly from Borneo and Sumatra. The entire production of this article—about 3,000 pounds—with trifling exceptions, finds its way to China, in which country it is highly prized for its medicinal virtues, and where it commands a high price. One pound of Borneo camphor commands from fifty to eighty times the price of ordinary camphor. 3d. Blumea camphor, derived from a plant which grows in the East Indies, likewise finds its way chiefly to China, where it is used partly as a medicinal agent, and to some extent also to perfume the so-called India (or China) ink. Its price is about ten times that of ordinary camphor, for which reason it is not a common article of commerce. Its chemical composition is identical with that of Borneo camphor.

These three varieties embrace many of the substances that are at present known by the name of camphor. The only variety that is of importance in the arts is the variety known as Japan camphor. It exists in the leaves, flowers, wood, and roots of *Laurus camphora*, and is obtained either by making incisions in the bark—where it is designed to spare the tree—or by felling the tree. A number of other plants likewise yield camphor, as, for example, the marjorum, lavender, sage, rosemary, etc. The camphor separates from the ethereal oils obtained from these plants by long standing.

Camphor is formed likewise by the action of nitric acid on many ethereal oils; it is formed also by continuous boiling of amber with nitric acid; also by treatment of turpentine oil with permanganate of potassa; and it is formed likewise from many substances by treatment with appropriate chemical reagents.

The production of camphor on the island of Formosa, in Japan, and in China, is conducted, even at present, in a very irrational manner. The finely-split wood of the camphor tree is exposed to the vapor of boiling water, with which the camphor volatilizes. For this purpose the fragments of camphor wood are placed in a suitable vessel (or boiler), covered with water, and upon the vessel is placed a cover or pot of clay, partly filled with straw. Upon heating the water sufficiently, the camphor is volatilized and deposits itself as a gray or reddish, fine-grained powder between the pieces of straw, from which it is afterwards separated by sieving. The crude camphor obtained in this manner comes into market in chests lined with lead foil, and of about 140 to 150 pounds weight, or in tubs containing about 200 pounds.

It will surprise no one to know that with a substance so comparatively costly as camphor, adulterations are very common. Stones, sand, but chiefly finely pulverized salt, are frequently found in the masses of the crude material, which occasionally contains only enough camphor to conceal the fraud. It is said that a Boston manufacturer found the head of a negro in a chest of this substance. Another mode of adulteration consists in moistening the crude material, while being packed, and afterwards while in transport, with water, of which the camphor takes up a considerable quantity. The purpose of this form of falsification is obviously to secure an increase of weight.

According to another method of obtaining camphor, which appears to be now generally practiced, the finely chopped fragments of the wood and of the roots of the camphor tree are placed in an iron boiler which is provided with a high wooden attachment; a very small quantity of water is added, and the vapors that are evolved, by a moderate and prolonged heating of the boiler, are condensed in a closed condensing chamber partly filled with water. Camphor and camphor oil condense and collect on the surface of the water in the condensing vessel, and at the close of the operation are removed. The camphor oil, which makes about 25 per cent. of the product, is pressed out from the camphor, and in spite of its powerful odor and the smoky flame it yields, it is used by the poorer classes as an illuminant. The spent camphor-wood chips serve as fuel for heating the boiler for subsequent charges.

The refining of the camphor, until within the past few years, was conducted in quite as primitive a manner as the preparation of the crude product. The chief condition of the purification of crude camphor by the old method was to secure the complete removal of water, which could only be accomplished by subliming it over freshly burned lime, when the sublimed camphor attached itself to the upper part of the sublimation chamber. For this purpose a number of glass flasks, with slightly flattened bottoms and wide necks, each capable of containing from 4 to 6 pounds, were filled about half full with the crude material, the necks were carefully freed from particles that might have attached themselves, and they were then placed upon a sand-bath (50 or 100 together), and the camphor was slowly sublimed and condensed in the upper part of the glass flasks. For this operation it was very important to regulate the fire. If it was allowed to become too hot, the sublimate was remelted and fell back again to the bottom of the flask; and if the heat was not great enough, the camphor sublimed in snow-like masses, in which form it was not a desirable commercial article. When the operation was finished, it was necessary to break the flasks to get at their contents, and the glass fragments had to be carefully separated from the adhering camphor by hand.

By another method of purification, which was, however, the same in principle as that just described, the sublimation was effected with the aid of iron vessels. Here the uncertainty was complete, as the operation could not be seen, although, on the other hand, the apparatus was not lost. The cover of the vessel required to be made of some material that would not rust, or to be lined with a covering of this character, in order that the product should have a commercial value. Lead-lined iron chambers have been proposed for this purpose, in which the leaden lining with adhering sublimed camphor could be withdrawn, the camphor broken off, and the lead lining returned; but the method was found to be troublesome and laborious.

Another method involved the sublimation of the camphor in a separate chamber, in which it was melted; but this was found to be attended with the difficulty that sublimates of various densities were obtained, and the resulting product was not uniform in quality.

Lately, however, a process has been devised by Mr. William Simes, a Philadelphia druggist, which differs in many essential features from those that have been described, and which is at present being worked on a large scale very successfully. With all the methods thus far described, we have seen the complete desiccation of the crude substance was the important preliminary step. In the process of Mr. Simes the object is to obtain the sublimate in the form of a finely pulverulent snowy mass, for which purpose about one-tenth per cent. of water is generally added to the crude material before sublimation. The apparatus of Mr. Simes consisted of a flat iron chamber, capable of holding about 200 pounds, which was connected by means of an iron tube with a condensing chamber 8 feet long, 4 feet wide, and 4 feet high, constructed of heavy glass plates, in which the sublimed camphor was collected. After an operation was finished, the apparatus was allowed to remain undisturbed over night, to become sufficiently cool, and the next day the sublimed camphor was removed and subjected in moulds to a pressure of 2,500 pounds per square inch in a hydraulic press, and the finished product obtained in small cakes highly compressed, and weighing 1 ounce.

As Mr. Simes felt the need of facilities for carrying on his method on a large scale, he shortly arrived at an understanding with the Pennsylvania Salt Manufacturing Company, to undertake the manufacture of compressed camphor extensively, and Mr. Bihn was called upon to construct an apparatus capable of working from 2,000 to 3,000 pounds per day.

The kind of apparatus for volatilizing the crude material gave no trouble. For this purpose he introduced a cylindrical steam boiler, 20 feet long and 4 feet in diameter, which was provided with the necessary openings for filling and for the escape of the volatilized camphor. The boiler is so set that it is not touched at any point by the direct fire, and to this end it rests throughout its entire length upon an arch of fire brick, and the flame is kept under complete control by means of dampers. The construction of the condensing chamber gave considerable trouble, since, on account of its size, the use of glass plates was not to be thought of. On this account, Mr. Bihn constructed the condensing chamber of leaden plates weighing 6 pounds to the square foot, in the same manner as those are used in the lead chambers employed in the manufacture of sulphuric acid. This condensing chamber was connected with the distilling vessel by means of an iron tube 15 inches in diameter, and the door of the condensing chamber was closed hermetically with the aid of rubber strips.

Upon the completion of this plant, including steam boiler, condensing chamber, steam engine, press, etc., the manufacture was started. Meantime a magazine specially constructed for the purpose had been built, in which was stored crude camphor to the value of about 100,000 dollars. The magazine was provided with a double roof, in order to guard as much as possible against the very considerable loss of the material by volatilization in the summer months. In spite of this provision, however, the loss is a very considerable one. In summer it amounts to 8 per cent., during the spring and autumn it is about ½ to 1 per cent., while in winter the loss is inappreciable.

Soon after the manufacture was under way, it became evident that the construction of the condensing chamber of lead plates was a mistake. A stratum of camphor of about ¼ inch thickness, which adhered firmly to the plates, was found to be strongly impregnated with lead, while that accumulating on the bottom was free from impurity. It required constant and careful attention to separate the lead-impregnated crusts falling from the roof and walls of the chamber from the pure sublimate. By an unfortunate accident the condensing chamber and the press-room, together with a portion of the machinery, were burned down; the distilling apparatus and steam engine were uninjured.

In re-erecting the plant, Mr. Bihn, profiting by his former experience, constructed the condensing chamber of enameled bricks set in Portland cement, forming the arched roof and the floor of the same material. The new condensing chamber was made 30 feet long, 16 feet wide, and 11 feet high. The chamber is strengthened with iron sheathing, the doors are of iron, and double, and the whole construction fireproof.

The operation as now conducted is as follows: The distilling chamber is charged with about two tons of crude camphor, all openings carefully closed, and distillations gradually effected. The operation requires generally about fifteen hours, and usually three operations are conducted in rapid succession. The apparatus is then left undisturbed for twenty-four hours to cool off, before the condensing chamber is opened. The snow-like masses of camphor, often 20 to 24 inches deep, are then removed, and either packed in barrels for sale as they are, or pressed into cakes, 12 inches square and about ¾ inch thick, in the hydraulic press under a pressure of 2,500 pounds to the square inch.

The compressed cakes are then sawed with a band saw into rectangular blocks weighing 1 ounce, each of which is wrapped in paraffined paper, and thereupon packed in boxes holding various quantities. The boxes holding two pounds find the largest sale. The advantage of the compressed camphor is chiefly that it does not volatilize as rapidly as the pulverulent or granular masses obtained by the usual methods of sublimation here described.

* Read before the German Technical Society of Philadelphia.

MERESSE'S TACHYGRAPH.

THE apparatus represented in the accompanying cuts, called by its inventor, Mr. Meresse, a "tachygraph," is a modification of the ordinary pantograph of draughtsmen. Like the last-named instrument, its object is the reproduction of like figures, with an alteration of their dimensions according to a definite proportion.

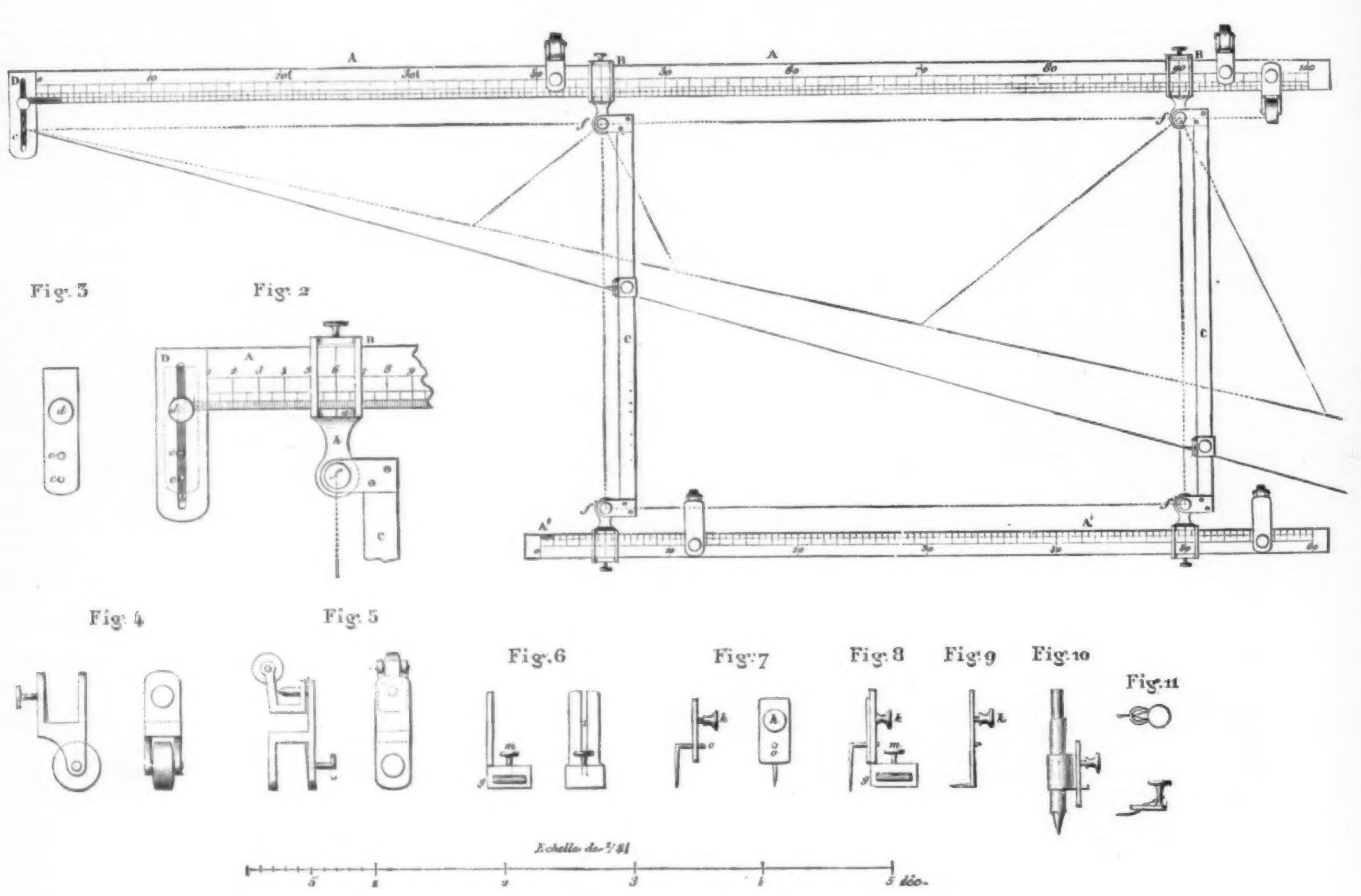
As in the pantograph, Mr. Meresse employs a jointed parallelogram, but one whose two opposite sides have a constant length, the two other sides being rules divided in the same manner, and one of which is prolonged to the center of similitude. It may be said that the Meresse tachygraph represents in plan the beam of a steam-engine provided with a Watt's parallelogram. The beam here is carried on rollers which facilitate the moving of the piece over the figure. The fixed point is held in a slide which permits of regulating its position at will, so as to bring it upon the straight line passing through the centers of the joints of the two coupling bars. The whole apparatus is confined within a plane very near that of the paper, thus reducing the deviations to which the pencil and the style would be exposed as a consequence of the warping of the parts.

The short rule is of wood, as is also the long one. The bars which connect them are of copper. All the joints situated outside of these different parts form the summits of the geometrical parallelogram whose play effects the transformation of the figure. In order to place the style and pencil, it is only necessary to find with certainty that their extremities are in a right line with the center of similitude. They fall, moreover, on the right lines which limit laterally the jointed parallelogram.

It may be seen that in such a system as this, where the parallelogram is reduced to its four geometrical summits, a slight alteration of the material sides may always be corrected by a proper regulation of the pieces. Before commencing operations there are certain verifications to be made, and these consist in ascertaining whether three points are in a right line, and, if not, bringing one of them upon a right line that coincides with that upon which the others are situated. The coincidence once obtained, the instrument is regulated, and operations may be begun. Such a preliminary preparation as this may be likened to the tuning of a stringed instrument.

The use of a wooden pantograph of large dimensions is accompanied with considerable expense, and does not insure of a great amount of exactness, inasmuch as the warping of wood of considerable length is an inevitable occurrence. Such an inconvenience is avoided in the tachygraph by having a means of regulating the apparatus.

A few other details, explained hereafter, complete the tachygraph, and make it a very convenient and practical instrument for reducing to a scale when very great precision is not required.



MERESSE'S TACHYGRAPH.

Explanation of the Figures.—Fig. 1.—General view of the instrument mounted ready for use. The different positions are denoted by dotted lines. Fig. 2.—A, large rule divided into centimeters and millimeters from 1 to 100, beginning at the aperture, *b*, of the copper square, D. B, two slides, open above, so as to allow the divisions to be seen which come in contact with the datum line, *a*, traced on the lower side. This line corresponds with the center of the axes, *f f*, which form the summits of the geometrical parallelogram. Two other similar slides, adapted to the smaller bottom rule, A′, at the same distance apart, determine the other summits, *f′ f′*. C, two copper rules, bent at their extremities and containing an aperture for the reception of the axis, *f*, which forms a part of the lower side of the slide, B. Fig. 3.—A slide which fits in the under side of the square, D, and which contains at the lower extremity an aperture, *c*, for the reception of the axis whose center is the point of similitude; *d*, a screw which fixes it to the square, and *e*, a guide which holds it in its perpendicular direction. Fig. 4.—Front and profile view of one of three rollers affixed to the large rule. One of these rollers is situated toward the axis, at any point whatever; the second, a little to the left of the second slide; and the third is placed at will either to the left or to the right of the first slide, but external to it. The height of the rollers is so calculated as to raise the apparatus 7 to 8 millimeters above the table.

Fig. 5.—Front and side view of the two jointed rollers which are adjusted to the small rule, A′, a little to the left of the slides. Fig. 6.—Front and profile view of the style-holder and pencil-holder slides that are adapted to the rules, C C, of Fig. 1, which pass through the aperture, *g*. *m*, a pressure-screw for fixing them to the rules. *i*, an aperture for the reception of the base of the screw, *k*, and the guide, *o*, of the slide, Fig. 7, the latter being shown in front and profile. Fig. 8.—A slide which carries a needle or vertical style, the height of which may be regulated by the screw, *k*. Fig. 9.—Profile view of horizontal needle. Fig. 10.—Pencil-holder and its slide, which is adapted, like the style, to the same supports, and is fixed in the same way. The two points of the style and pencil fall on the line passing through the center of the two axes, *f f′*, that is to say, at one centimeter from the left side of the rule. Fig. 11.—Front and plan view of a button serving to stretch a thread which is attached at the other end to a small ring 7 or 8 millimeters in diameter, into which is introduced the axis of the large rule before fixing it to the table. At whatever point it be fixed, whether below or above, this thread always forms a right line, starting from the center of similitude. It serves to regulate the instrument, and to put it in a state in which it will operate with precision. To do this the operator brings the two axes of the upper slides on the well stretched thread by slightly loosening the screw, *d*, of the slide in the square, D, and moving it in one direction or the other until the coincidence is exact.

A Sulphur Oxychloride. — This new compound has been obtained by heating together to 250° in a sealed tube, a mixture of equal weights of sulphur chloride and sulphuryl chloride. It boils at 60° to 61°, and is readily decomposed by heat. It is a deep red liquid of the sp. gr. 1·656. Its vapor-density taken with Meyer's apparatus is given as 3·98, 3·84, 3·75. The author ascribes to it the formula S_2OCl_4.—*J. Ogier, in Comptes Rendus.*

THE DOLBEAR TELEPHONE IN ENGLAND.

At a recent meeting of the Society of Telegraph Engineers and of Electricians, London, a paper was read by Professor A. E. Dolbear, on "The Development of a New Telephonic System."

The first known experiment in which an attempt was made to produce musical sound by electrical means appears to have been that of Page, in 1837. The arrangement consisted of an iron bar surrounded by a wire coil; when intermittent currents of electricity were sent through the wire coil a lengthening and contraction of the bar took place at each make and break, this change producing a "tick;" when the makes and breaks followed one another with rapidity the ticks produced a musical sound. These makes and breaks were not made automatically.

The next instruments appear to have been made by Farmer; his apparatus consisted of an electro-magnet fixed on one side and within a wooden box, an armature being placed opposite the poles of the magnet and fixed on the opposite side of the box. When an electric current was sent through the electro-magnet, the side of the box on which the armature was fixed was drawn toward the magnet, and if a series of makes and breaks took place rapidly the box gave out a musical sound. Farmer used as a transmitting apparatus a number of harmonium reeds with contacts fixed to them. He thought that he might be able to transmit articulate speech with his apparatus, but failed in his attempts. Subsequent work on the electrical transmission of musical sounds was done by Helmholtz, who used tuning forks. Reiss then followed with his well-known apparatus; he undertook to transmit articulate speech. The problem that was required to be solved was that of producing *variation* of the electric current; this, Professor Dolbear said, Reiss evidently intended to produce with his apparatus, since at that time the possibility of effecting variation must have been understood, from the simple fact that in making up batteries, etc., it was known to be necessary to screw up all connections quite tight, otherwise the passage of the current became obstructed.

The original apparatus of Reiss was made in 1863, by Albert, but Reiss did not confine himself to that particular form; he made numerous experiments with various modifications of the original form; these were all exhibited in the recent Electrical Exhibition at Paris. Professor Dolbear drew particular attention to a form of the Reiss instrument in which the box was of a shallow form. The receiver which Reiss invented was that of Page, mounted on a sounding board. Will this receiving apparatus of Reiss produce articulate speech? As the apparatus will respond to varying currents, it possesses all the essential elements for producing speech, though the effects are very meager. Reiss evidently expected or aimed at the apparatus speaking out quite loud; this no apparatus existing at the present day will do. Reiss in 1863 tried another receiver beside that of Page, formed of an armature set at the end of an electro-magnet. It is curious that very little serious attention has been paid to the later apparatus of Reiss. Professor Dolbear considered that Reiss had invented a transmitter that would vary the current, and a receiver that would produce articulate speech, *i. e.*, he had produced a complete telephone system. In 1876, Professor Bell brought out a new system, quite distinct from that of Reiss. This invention was the first in which it was proposed to speak to the armature of an electro-magnet; an improvement on the first arrangement was the substitution of permanent for electro-magnets. This was done by Professor Dolbear, in 1876. The action of the magnetic telephone when used as a transmitter, was too feeble for practical purposes, and it was soon seen that some form of apparatus was necessary by which the current could be varied. Attention was therefore turned to Reiss's apparatus, to see whether it could be made more efficient. It was soon found that the platinum contacts would not work properly, as they were liable to become fused together. Edison proposed the use of lamp-black carbon, and he thought that the action was to compress the latter. Professor Hughes showed that hard carbon was equally efficient. If this latter substance is substituted in the place of the platinum in Reiss's apparatus we have a perfect transmitter. Various properties of the electric current, such as chemical action, heating effect, have been employed for actuating the transmitter. In the electro-motograph of Edison the chemical effect is made use of. An arrangement somewhat similar to that of Edison had been tried by Professor Dolbear; it consisted of an iron cylinder on the periphery of which rested a small horse-shoe magnet fixed to a diaphragm; a coil of wire surrounded the iron cylinder. When the latter was rotated, the horse-shoe magnet, by clinging to it, became drawn forward and kept the diaphragm in a state of tension, as in the electro-motograph; when a current of electricity was sent through the coil of wire, the iron became magnetic and reduced the friction between the horse-shoe and the iron, thus allowing the diaphragm to spring back, the amount of this depending upon the strength of the current. This apparatus was called a "rotophone."

Prof. Dolbear then showed that an ordinary sounder or relay, if it had a proper ear-piece attached to it, would be found to answer as a receiver. For some time it had been known that a Leyden jar, when charged or discharged, gave out sounds, and in 1863 Sir William Thomson had noticed a similar effect in an air condenser. Subsequently Dr. Wright, by placing two pieces of paper silvered on one side only, back to back, and connecting the sheets to an induction coil, the primary of which was in the circuit of a Reiss transmitter, obtained musical sounds. Varley, later on, made similar experiments with larger condensers, formed of loose sheets of tin foil. As regards his own (Prof. Dolbear's) apparatus, he would mention that he was not led up to the idea as the result of the foregoing experiments. He had attempted to make a receiver of two plates, between which various liquids were placed. He anticipated that the instrument so made would respond from the disengagement of gas on the plates, and this proved to be the case. Having experimented on one occasion with a receiver of the foregoing description, which had become emptied of its contents through leakage, he found that the instrument still responded perfectly.

Prof. Dolbear then described the general principle on which his receiver worked, and he remarked that the principle of the attraction of electricity through a space was a very important one, and deserved to be more carefully studied than it yet had been. He had tried plates of various dimensions for his receiver, and had found that a size of about three inches gave the best effect. With reference to Herz's "singing condenser," he said that no advantage was gained by multiplying the number of the plates, in fact there would be a loss of effect by doing so. The principle of the

instrument he considered to be wrong. The best effect was produced in the Dolbear receiver by a high tension current, and he had used as a transmitter to vary such a current two points close together, whose distance was varied, so that the air space offered more or less resistance to the passage of a spark. He found that a resistance of 3,000 ohms for the secondary wire of the induction coil gave the best effect. The resistance through which the receiver would work was enormous; he showed that it would even work when there was discontinuity in the circuit, that is, when the receiver was simply held near the end of the line wire; even a distance of fifty feet between the two did not entirely extinguish the sound. It was not necessary to put the second plate of the receiver to earth, though the effect was louder. In the latter case the instrument would even speak with the second plate, made of ebonite, this plate being excited by slight friction to electrify it. His apparatus had been worked through 256 miles of wire in very wet weather, and the effect was as good as in fine weather.

It was stated that the instrument was not affected by an amount of induction which would spoil the working of the ordinary telephone.

THE CRYSTAL PALACE ELECTRICAL EXHIBITION.

AMONG the minor exhibits at the Palace are some very interesting and ingenious contrivances. Thus Mr. Macdonald shows his holophote course indicator Figs 1 and 2, which may prove very useful on board ship. It consists of an electric lamp, A, Fig 1, with a reflector, B, set on a movable handle, C C. This handle is held fast by two detents, D D', while the rudder is amidships. When the helm is put to port, an electric circuit is established through the electro-magnet, E E, by which the detent, D, is drawn downward, and the handle, C C, set free to move, so that the reflector, B, can swing round, and the light be made to wave to starboard. As the handle swings round, the screen, F, is forced upward by the curved bar, G G, and the pointed inner end of the arm on which the screen, F, is pivoted pushes back the spring, H, and drops into a slot in the top of the spring, which thus holds the screen upright and shuts out the light. The handle is then moved to its original position, when the spring, H, being pressed back by the bar, I I, the point of the arm carrying the screen, F, is set free, and F, falling down, exposes the light again. What we have said about the detent, D, answers also for D', which is pulled down by the electro-magnets, E' E'. The operation indicated of releasing the detent, D, and swinging the light to starboard, or releasing D' and swinging it to the opposite quarter, can be carried on indefinitely. Fig. 2 shows the light streaming in one direction. It will be seen that by such means as is here shown the course of a vessel and every action of her helm can be shown to those who are on the look-out.

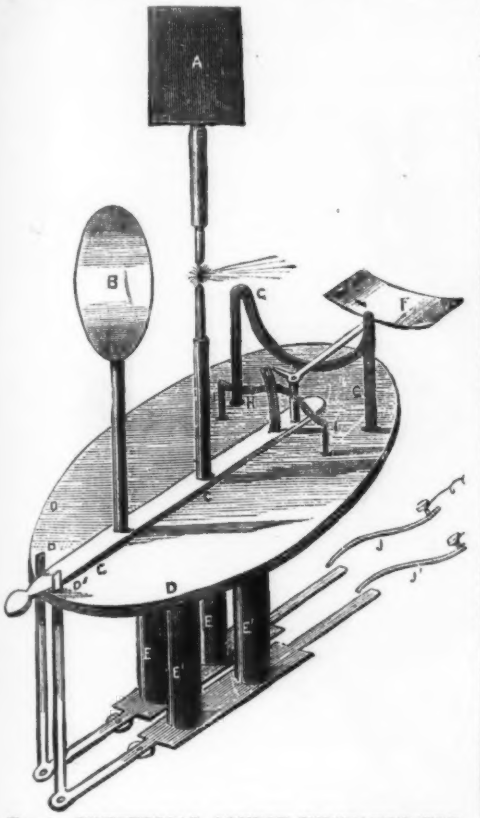


FIG. 1.—ELECTRICAL COURSE INDICATOR FOR SHIPS.

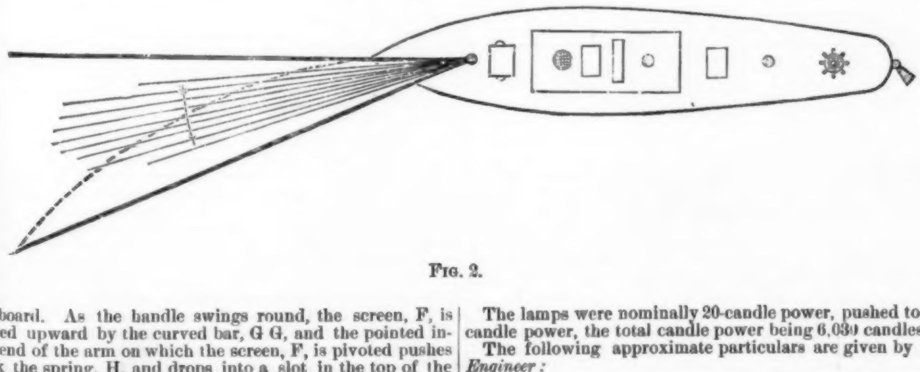


FIG. 2.

THE SELLON AND VOLCKMANN SECONDARY BATTERY.

The new secondary battery, of which a good deal has been published without stating by whom it was made or invented or what it was like, was recently exhibited and shown in operation to the Prince and Princess of Wales in the Alhambra Courts of the Crystal Palace, by the Electrical Power Storage Company, of 74 Hatton Garden. The battery is the result of the labors of several inventors, among whom are Mr. E. Volckmann, Mr. Sellon, and Mr. Swan, and it is, it need hardly be said, entirely different in construction from the Faure battery, of which so much has been heard and comparatively little seen. For the purpose of the display, the Alhambra Court is richly furnished in the Moorish style, and electric chandeliers or candelabra have been specially designed by Mr. Johnson, a pupil of the late Owen Jones. Of the design of these fixtures and fittings we can only say that they must be seen to be appreciated. Altogether they carry 201 incandescent lamps, all of which are connected up to 33 of the new batteries out of 38 at present in an inclosed space next the engine and machine shed of the Brush Corporation. The 33 are connected up to a switch-board in such a way that the current from any number from about 10 to 33 may be put in circuit by simply turning the switch handle, and thus anything from a very dim to a very bright light may be used as required.

The cells each contain twelve elements, each about 20 in. by 15 in., and about $\frac{3}{16}$ in. in thickness, and placed in a box of about 25 in. by 16 in. by 7 in., the whole weighing about 370 lb., and containing about 295 lb. of metallic material. Each cell stores electric energy equivalent to about 5-horse power for one hour, which can be used at the rate of fully 40 ampères per horse-power, or say 200 ampères. The plates are closely perforated with holes about half inch diameter, the holes being afterward filled with a composition, the exact nature of which we are not yet at liberty to make known, further than to say that it is such that it expands when the plates are first polarized, and thus finds itself under a pressure sufficient to cause a considerable superficial extension of the positive plate. Perfect metallic contact between the composition and the material of the plates is thus permanently insured, so that the plates cannot become inactive by local action or by deposit of a salt of lead between the composition and the walls of its containing holes forming a solid mass of alloy. The plates are strong and are maintained at a very short distance apart by splines of wood, and stand with their longest dimension vertical. They are connected up to a plate on the top of the cell in a very simple way, the whole producing a perfectly satisfactory, efficient, and practical battery, having neither of the chief faults of the Faure battery.

From the figures we have given, and to which we shall add on an early occasion, it will be seen that the weight of the battery per one hour horse-power is about 60 lb. of metallic composition. To give off 400 horse power for one hour or 200 horse power for two hours would thus require about 10 tons of batteries, and for the 201 Lane-Fox lights in circuit, a little over $4\frac{1}{2}$ tons were coupled up.

The Lane-Fox lamps are 20 candle power pushed to 30-candle power, so that the weight of battery coupled up was 1·65 lb. per candle, or 50·14 lb. per 30-hour candles.

It is generally acknowledged by electricians that without a satisfactory secondary battery domestic electric lighting cannot become general. This is not, however, confined to domestic lighting, but applies to lighting public buildings and to many other applications of electricity. Something must be had which in an electric lighting system, or in an electromotive power system, will take the place represented by the gasometer in the gas-lighting system and by the accumulator in a hydraulic power system. The battery which will do this is now provided, and the application of electric currents will probably make more rapid advance from this time than it has done even within the past three years. The new battery may be made to meet any requirements. It may be of small size to go into the place of the gas meter in a house, or in large masonry tanks for extensive public buildings; and it will probably be made to fill very large tanks at central electric lighting and power-generating stations, so that smaller engines running continually may take the place of large engines running as at present only during the hours that lights are required. It will be possible to obtain a light or work an electric motor at any time by one movement of a handle, and the batteries will probably, in some cases, constitute the motor for domestic lighting. One of each pair of the elements or plates will last almost indefinitely, while the other will only require renewal when constantly in use about once in, say, fifteen months, as far as can at present be seen, and they may turn out to be made more durable. They are easily renewed, and the batteries require no attention whatever, except for a little filling up at long intervals of the acidulated water in which the plates are immersed.

The lamps were nominally 20-candle power, pushed to 30-candle power, the total candle power being 6,030 candles.

The following approximate particulars are given by the *Engineer*:

No. of lamp.	Luminous surface, square inches.	Candle-power.	Resistance, hot, ohms.	Current, ampères.
A	0·157	20	38·2	1·6
B	0·102	12	38·0	1·2
C	0·157	20	20·5	2·25
D	0·102	12	62·0	1·00

ANOTHER ELECTRIC RAILWAY.—The second electric railway constructed by Messrs. Siemens and Halske in Berlin was formally opened, April 29. It runs from Lichterfelde, a suburban station on the Berlin-Anhalt Railway, to the Military Academy, about one and a half English miles.

ELECTRIC RAILWAYS.

PROFESSOR W. E. AYRTON, F.R.S., lately gave a lecture on electric railways in London. He briefly reviewed the history of the various modes of propulsion on railways down to Colonel Beaumont's air engines and Siemens' and Edison's electric engines. He then gave a full account of the electric railway system devised by Professor Perry and himself, to overcome the objections particularly as to conductors which belong to the hitherto tried systems. Instead of supplying electricity to one very long, perhaps imperfectly insulated rail, they lay by the side of the railway line a well insulated cable, which conveys the main current. The rail, which is rubbed by the moving train, and which supplies it with electric energy, is divided into a number of sections, each fairly well insulated from its neighbor and from the ground; but at any moment only that section or sections which is in the immediate neighborhood of the train is connected with the main cable, the connection being made automatically with the moving train. The loss of power by leakage is very much lessened. For the purpose of automatically making connection between the main well-insulated cable and the rubbed rail in the neighborhood of the moving train they have devised the apparatus shown in the following figure:

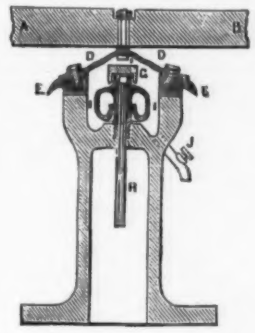


FIG. 1.

A B is a copper or other metallic rod resting on the top of and fastened to a corrugated tempered steel disk, D D—of the nature of, but of course immensely stronger than, the corrugated top of the vacuum box of an aneroid barometer—and which is carried by and fastened to a thick ring, E E, made of ebonite or other insulating material. The ebonite ring is itself screwed to the circular cast iron box, which latter is fastened to the ordinary railway sleepers or buried with only the top above ground. The auxiliary rail, A B, and the corrugated steel disks, D D, have sufficient flexibility that two or more of the latter are simultaneously depressed by an insulated collecting brush or roller carried by one or by all of the carriages. Depressing any of the corrugated steel disks brings the stud, F, which is electrically connected with the rod, A B, into contact with the stud, G, electrically connected with the well-insulated cable.

As only a short piece of the auxiliary rail, A D, is at any moment in connection with the main cable, the insulation of the ebonite ring, E E, will be sufficient even in wet weather, but the insulation of G, which is permanently in connection with the main cable, must be far better. The gutta percha or India-rubber covered wire coming from the main cable is led through the center of a specially-formed telegraph insulator, and causes it to adhere to the inside of the earthenware tube forming the stalk; and as the inside of each contact box is dry, a very perfect insulation is maintained.

The existence of these contact boxes at every 20 ft. to 50 ft. also enables the train to record its position graphically at any moment on a map hanging up at the terminus, or in a signal-box or elsewhere, by a shadow which creeps along the map of the line as the train advances, stops when the train stops, and backs when the train backs. This is effected thus: As the train passes along, not only is the main contact between F and G automatically made, as already described, but an auxiliary contact is also completed by the depression of the lid of the contact box, and which has the effect of putting, at each contact box in succession, an earth fault on an insulated thin auxiliary wire running by the side of the line. And thus the moving position of the earth fault—that is, the position of the train itself—is automatically recorded by the pointer of a galvanometer moving behind a screen or map, in which is cut out a slit representing by its shape and length the section of the line on which the train is, as shown in Fig. 2. In addition, then, to the small sections of 20 ft. or more into which the auxiliary rubbed rail is electrically divided, there would be certain long blocked sections one mile or several miles in length, for each of which on the map a separate galvanometer and pointer would be provided.

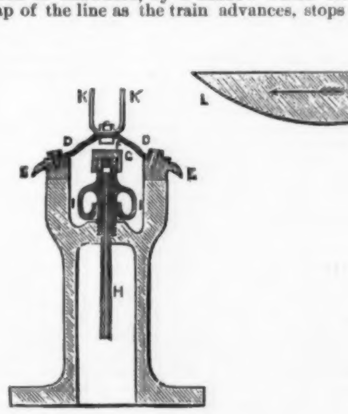


FIG. 2.

A model was exhibited, divided into four sections, and it was shown by current detecters that as the train runs either way it puts current into the section just entered, and takes off current from the section just left. The train not only takes off current from the section, A, when it is just leaving

it, and entering section B, but no following train entering section A can receive current or motive power until the preceding train has entered section C. When a train runs on to a blocked section it is quickly pulled up, because it is not only deprived of all motive power, but is powerfully braked, and when the current is cut off from a section the insulated and non-insulated rail of that section are automatically connected together, so that when the train runs on to a blocked section the electromotor becomes a generator short circuited on itself, producing, therefore, a powerful current which rapidly pulls up the dynamo-electric engine.

ELECTRIC RESISTANCE OF A MIXTURE OF SULPHUR AND CARBON.

AT a recent meeting of the Physical Society, Mr. Shellford Bidwell read a paper on the above. These experiments were begun in December, 1880, to ascertain if the mixture in question was sensitive to light like selenium. Sulphur was melted and mixed with powdered plumbago, the best proportions being 20 parts by weight of the sulphur to 9 parts of the plumbago. The mixture was poured into moulds and quickly cooled, yielding plates and sticks. When exposed to the light of a gas flame, an increase in resistance was noticed, and was proved to be due to the heat of the flame, not the light, by experimenting with different sources of light and colored screens of glass. As both carbon and sulphur decrease in resistance under heating, this opposite effect of the mixture is anomalous, and Mr. Bidwell explains it by supposing that the mixture is mechanical, and that heat, expanding the size of the insulating sulphur crystals, separates the conducting carbon particles further apart, and increases the resistance of the mass. Cells of this compound were made like selenium cells by spreading it between the parallel turns of two fine platinum wires wound round a mica plate, and the rise of resistance for temperature carefully measured. At 14° C. the resistance was 9,100 ohms, at 55° C. it was 5,700 ohms, and the rise was in greater ratio than the rise of temperature. Mr. Bidwell also found that these cells would transmit speech when connected in the circuit of a battery and a Bell telephone; they also acted as a thermoscope, when employed after the manner of a thermopile. Mixtures of shellac and graphite, of paraffin and graphite, etc., were also tried with like results.

The resistance of the cells decreased soon after being made. Mr. Bidwell also stated that, acting on a suggestion of Dr. Hopkinson, he had found that the resistance diminished under a more powerful current. This material would not answer for resistance boxes.

THE PIESIGASTER.—A NEW SPECIES OF SERPENT.

OUR engraving, which we take from *La Ilustracion*, of Madrid, represents a new species of serpent called Piesigaster, of the genus Boides, discovered not long ago in the Philippine Islands, by the distinguished naturalist, Jose Domingo Seoane.

ON THE POISON OF SERPENTS.

A FEW months ago we gave a summary of the researches of Prof. Selmi and Dr. Gautier on a newly-discovered class of animal poisons. These compounds, the so-called ptomaines, were found to agree in all their essential properties with the venom of serpents. Both appeared to be definite chemical "individuals," capable of crystallization, retaining their fatal properties after boiling, acidulation, repeated filtrations, desiccation, and even heating up to 257° F. for several hours. On the other hand, by a sufficient degree of dilution or by a reduction of the dose, they might be rendered harmless. On the faith of these observations Dr. Gautier argued—and as it seems to us quite legitimately—that snake-poison could not be a virus or figured ferment, owing its deadly efficacy to the presence of microbia or organic germs, as is the case with the *materies morbi* of splenic fever, etc. We pointed out then that the eminent Brazilian physician, Dr. de Lacerda, had come to very different conclusions. The views of the latter *savant* appear to have been indorsed by one of the chief representatives of French official science—M. de Quatrefages—in a memoir presented to the Academy of Sciences. This paper we shall beg to lay before our readers, promising that, while Dr. de Lacerda has experimented chiefly with the venom of *Bothrops jacaranda*, Dr. Gautier has examined that of a closely-allied species, the redoubtable lance-headed serpent of Martinique, which some zoologists place in the genus *Bothrops*.

M. de Quatrefages commences by referring to some of the cures effected by Dr. de Lacerda by the subcutaneous injection of a dilute solution of potassium permanganate. He says: "Among the cases recorded there are some exceedingly remarkable, where the injections have not taken place until eleven and twelve hours after the bite. Extreme swelling of the limbs, profound anxiety, and hemorrhage, inward or outward, all announced the approach of death. Yet after some injections all these symptoms have disappeared, and the wounded persons have been completely restored in a few days. These facts, collected in different parts of the Brazilian territory, and accompanied with minute details, seem to be beyond all doubt. They confirm the experiments made by Dr. de Lacerda in presence of the most competent judges, and with the assistance of one of our countrymen, Dr. Couty, a pupil of Claude Bernard.

"To comprehend all the importance of the discovery due to Dr. de Lacerda, we must remember that in those countries a certain number of persons succumb every year to the bites of various species of serpents. In Martinique alone, with a population of 125,000, the annual mortality from the bite of the lance-headed snake is fifty, not counting those who remain lame or infirm for the rest of their days. We see, therefore, what a service the eminent sub-director of the Physiological Laboratory of Rio Janeiro has rendered. France itself may profit by this beautiful discovery. Without doubt, of all our serpents, the viper alone is venomous, and its bite is far from being as formidable as that of its tropical congeners. Yet the viper does more damage than is commonly supposed. The question has been repeatedly laid before the Society of Acclimatization. In 1859 a commission was nominated to examine into the matter; an inquiry was instituted, and in 1863 a report was drawn up by M. Soubeiran. From the evidence collected during these four years it results that if some departments do not seem to produce vipers (Nord, Haute-Saone, etc.), and if in others they are rare (Meuse, Vosges, Bouches de Rhone, Oise, Corrèze), there are others where these reptiles swarm to such an extent as to constitute a real danger for the inhabitants of the country (Vendée, Loire-Inférieure, Haute Marne, Lot, Cote d'Or). Here rewards have at intervals been offered for the destruction of vipers. These measures have generally produced good results. In Haute Marne, in the year 1856, the number of these reptiles brought in to the local authorities was 17,415. In six years the destruction of 57,045 venomous serpents was officially certified.

"Unfortunately the inquiry led to no precise information as to the number and the nature of the accidents caused by the bite of vipers. It appears merely that our large domestic animals recover very rapidly, and without requiring any treatment, while sheep and goats frequently perish if they do not receive prompt assistance. It is often the same with dogs, especially if bitten in the nose. But even after a cure they often remain all their life long extremely weak, and suffer from defects of sight and hearing, which render them unfit for hunting.

"It has long been known that an adult man, if bitten by a viper, may recover spontaneously. But we know also that in this case the phenomena, both local and general, are more pronounced, and very often lead to a fatal termination. In any case they are ordinarily grave and painful. There is room to hope that the means of cure discovered by Dr. de Lacerda will enable the symptoms to be arrested promptly and with certainty. The process succeeds as well with animals as with men.

"In describing his process Dr. de Lacerda insists on the necessity of preparing the solution of permanganate at the moment when it is to be used. He makes up beforehand small packets of the salt, each containing 0·1 grm. (about 1½ grains), and a flask containing 10 grms. of water. He obtains thus, at the required moment, a solution of the exact strength needful. The injection is made by means of a Pravaz syringe. A ligature should be placed above the bite, and half a syringeful of the liquid should be injected into each wound made by the teeth of the reptile, and the tissues are then compressed to favor the diffusion of the liquid. If the limb is already swollen several injections should be made about the boundaries of the swelling. If the rapidity of the symptoms seems to indicate that the venom has been introduced directly into a vein, an injection should be made into a superficial vein.

"I may be permitted here to add a brief reflection: from researches anterior to those of Dr. de Lacerda it results that the venom of serpents owes its toxic properties not to the liquid itself which is secreted in the glands, but to corpuscles more or less analogous to those discovered daily in virus. Is there here a hint to be taken? Would potassium permanganate, so powerful against the venom of the *Bothrops*, do similar service if employed against some of the diseases the cause of which has been discovered by M. Pasteur?"

This memoir suggests a few remarks. We note, in the first place, that the learned academician accepts already as a demonstrated fact the efficacy of potassium permanganate for the bites of serpents. Now, unless our memory greatly deceives us, it has been tried repeatedly in vain for the bite of the cobra in India. We are, however, quite willing to admit that the poison of the cobra and that of the *Bothrops* may differ quantitatively, and even qualitatively, that of the former being beyond doubt the more malignant.

Still it appears somewhat rash to pronounce Dr. de Lacerda's method of cure successful just when its value has been referred to a Select Committee of the Academy for close examination. Pending the conclusion of such inquiry suspension of judgment would, we submit, be the proper course.

As regards the number of vipers in France, we fear that there has been an increase during the last twenty years. This has been especially the case in the Gironde, where their only efficient enemy, the hedgehog, has been much persecuted by gamekeepers. As regards the danger of the bite to man, we believe that it is much under-rated in zoological text-books. From evidence which has reached us, and from our own observations, we should think that about one case in five proves fatal, the danger increasing with the heat of the climate and of the season, and with the fatigue or the constitutional weakness of the subject. Many of our readers will recollect that a few years ago a young man died from the bite of a viper received on Leith Hill.

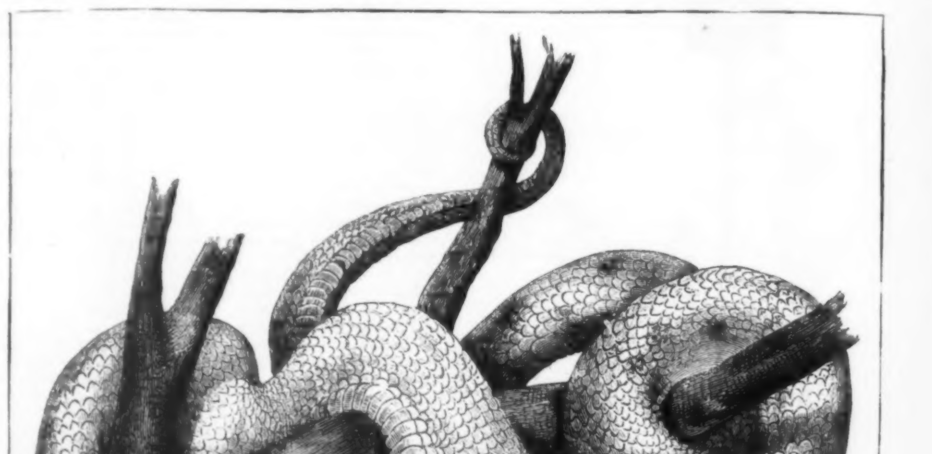
It must be remembered that these reptiles are increasing in England as well as in France, and from the same cause—the extirpation of the hedgehog. We have repeatedly seen them in Epping Forest, and in some of the Hertfordshire woods they are numerous. No one seems to have observed whether in England and France they show a marked preference for any particular kind of vegetation, as in Eastern Europe they do for the marsh-rosemary (*Ledum palustre*).

At the close of his memoir M. de Quatrefages formally accepts the ferment theory of serpent-poisons as if already established by "anterior researches." In so doing he completely ignores the investigations of his own eminent countryman, Dr. Gautier, as well as those of Dr. Winter Blyth.

There is another point which we cannot overlook: the remedy of snake-bites, if such a one exists, can only be found out by experiments upon animals, which in the hysterical cant of the day are denounced as "violationism," "diabolism," etc. We would therefore ask whether, seeing that in India alone some 50,000 persons perish yearly from snake-bite, such experiments are not the imperative duty of those who have the opportunity and the skill to perform them? If any person, whether prelate or homeopathist, whether judge or doctress, can suggest another method, the scientific and medical public are prepared to hear. Dr. de Lacerda has reached his conclusions solely by means of experiments performed upon animals!—*Journal of Science.*

The same number of the *Journal of Science*, from which we take the foregoing, contains the following:

M. Vulpian (*Comptes Rendus*) criticises the views of M. de Lacerda on the value of potassium permanganate as an antidote to snake poisons. He shows that the bite of *Bothrops jacaranda* in Brazil is not always deadly; he proves that the injection of a solution of permanganate into a vein is fatal, and that if it merely passes into the subcutaneous cellular tissue it will be decomposed, forming a clot of hydrated peroxide very near the point of injection, and being thus prevented from penetrating far. The poison, on the other hand, is not thus decomposed. He does not call in question the alleged character of the poison as being not a true chemical agent, but a ferment.



THE PIESIGASTER.—A NEW SPECIES OF SERPENT.

CHLORURATION OF CAMPHOR; FORMATION OF CAMPHOR BICHLORIDE. — The author dissolves camphor in absolute alcohol, and when the solution is cold passes through it a current of dry chlorine for four or five days. The compound, when purified, forms prisms of an intense white, insoluble in water, soluble to any extent in hot alcohol. It liquefies in contact with the vapor of ether.—*P. Cazeneuve.*

THE GREAT PYRAMID.

By RICHARD A. PROCTOR.

WE have seen that the Great Pyramid is so perfectly oriented as to show that astronomical observations of great accuracy were made by its architects. No astronomer can doubt this, for the simple reason that every astronomer knows the exceeding difficulty of the task which the architects solved so satisfactorily, and that nothing short of the most careful observation would have enabled the builders to secure anything like the accuracy which, as a matter of fact, they did secure. Many, not acquainted with the nature of the problem, imagine that all the builders had to do was to use some of those methods of taking shadows, as, for instance, at solar noon (which has to be first determined, be it noticed), or before and after noon, noting when shadows are equal (which is not an exact method, and requires considerable care even to give what it *can* give—imperfect orientation), and so forth. But to give the accuracy which the builders obtained, not only in the orientation, but in getting the Pyramid very close to latitude 30° (which was evidently what they wanted), only very exact observations would serve. Indeed, if a modern astronomer, knowing nothing about the Pyramid, were asked how the thing could be done without telescopic aid, he would be apt to say that no greater accuracy than (for instance) Tycho Brahe obtained with his great quadrant at Uranienburg could have been secured. Now, the orientation of the Great Pyramid approaches much closer to exactness than the best observations by Tycho Brahe with that justly celebrated instrument.

Seeing this, and observing that the ascending and descending passages are just such as the astronomer would make to secure such a result, we may accept, without a particle of doubt, the belief that they were made for that purpose.

Then we saw that the features of the Great Ascending Gallery were not such as would be essential, or even desirable, to increase or maintain the accuracy of the orientation, as layer after layer was added to the Pyramid, but are precisely such as would be essential if the Pyramid was meant to subserve (as one, at least, of its objects) the purpose of an observatory.

But persons unfamiliar with astronomy will say (several have said so in letters addressed to me): This great ascending gallery would only enable astronomers to observe stars when due south, or nearly so, and only those which, when due south, were within a certain distance above or below the point toward which the axis of the Great Gallery is directed. Were all the other stars left unobserved? And again, we know that the Egyptians, like all ancient astronomers, paid great attention to the rising and setting of the heavenly bodies, and especially to what was called the heliacal rising and setting of the stars. In what way would the Great Gallery help them here?

Now, with regard to the first point, we note that the chief instrument of exact observation in modern observatories, the one which, as it were, governs all the others, has precisely this quality—it is *always* directed to the meridian, and has, indeed, a very much narrower range of view on either side of the meridian than the Great Gallery had. And though it is indeed free to range over the whole arc of the meridian from the south horizon point through the point overhead to the north horizon point, it is mainly employed over about that range north and south of the celestial equator which was commanded by the Great Gallery. The visitor at Greenwich sees the great equatorial and imagines that to be the chief observing instrument. The comparatively unobtrusive transit circle seems far less important. But the time observations, which are far and away the most important observations made at Greenwich, are all made, or at least, all regulated, by the transit observations. So are the observations for determining the positions of stars.

When the equatorial is used to make a time or position observation, it is used as a differential instrument; it is employed to determine how far east or west a star may be (theoretically, how much it differs in right ascension measured by time) from another: and again, to show how far north or south a star may be (theoretically, how much it differs in declination) from another, whose right ascension and declination have already been determined by repeated observations with the transit circle. Similarly, the altitude and azimuth instrument is used in direct subordination to the transit circle.

The astronomers who observed from the Great Pyramid doubtless made many more observations off the meridian than on it. They made multitudinous observations of the rising and setting of stars, and especially of their heliacal risings and settings (which last, however, though we hear so much of them, belonged *ex necessitate* to but a very rough class of observations). They no doubt often used astrolabes and similar instruments to determine the positions of stars, planets, comets, etc., when off the meridian, with reference to stars whose places were already determined by the use of their great meridional instrument. But all those observations were regulated by, and derived their value from, the work done in the Great Ascending Gallery. The modern astronomer sees that this was the only way in which exact observations of the heavenly bodies all over the star sphere could possibly have been made; and seeing the extreme care, the most marvelous pains, which the astronomers of the Great Pyramid took to secure good meridional work, the astronomer recognizes in him a fellow worker. He says, with the poet:

> "I am as old as Egypt to myself,
> Brother to them that squared the Pyramids:
> By the same stars I watch."

And now consider what was this great observatory of ancient Egypt—the most perfect ever made till telescopic art revealed a way of exact observation without those massive structures. A mighty mass, having a base larger than the square of Lincoln's Inn, rising by just fifty layers to a height of about 142 feet, and presenting toward the south the appearance shown in Fig. 1, where the mouth of the Great Gallery is seen opening southward, and the lines are shown as "observing directions." The Pyramid observatory is shown in section in Fig. 2. It will be noticed that the successive layers are not of equal thickness. There are just fifty between the base and plane of the floor of the King's Chamber. The direction lines for the mid-day sun at midsummer, midwinter, and the equinoxes are shown; also the lines to the two stars, Alpha Draconis and Alpha Centauri, are given at the subpolar meridional passage of the former and the meridional passage of the latter, at the date when the descending and ascending passages thus commanded both these stars. Within fifty years or so on either side of this date, the Pyramid must, I should think, have been built. The later date, when Alpha Draconis was at the right distance from the Pole, 2170 B. C.,* is absolutely rejected by Egyptologists—not one being ready to admit that the date of the Pyramid King can have been anywhere near so late.

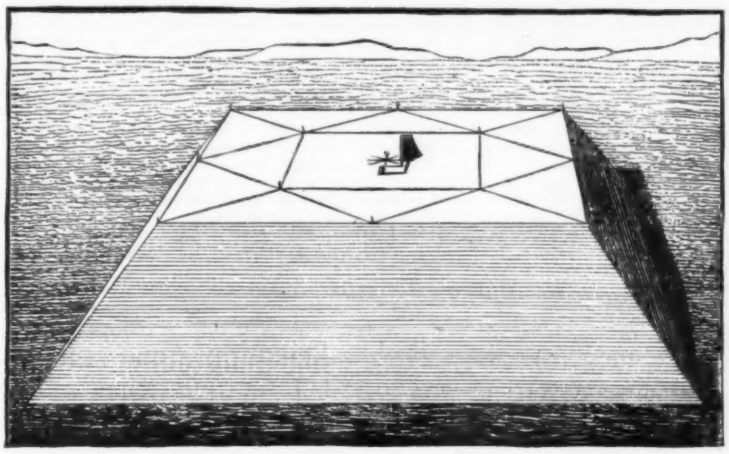


FIG. 1.—THE PYRAMID OBSERVATORY, SHOWING THE OBJECT-END OF THE GREAT OBSERVING TUBE.

Thus far all has been tolerably plain sailing. Of the astronomical use and purpose (not quite the same thing, be it noticed) of the Great Gallery, there can be small room for doubt, when we find (1) every feature in all the passages and in the Great Gallery correspond with the requirements of the theory, and (2) many features explicable in no other way.

But here our difficulties begin. Astronomy no longer lends its aid when we ask why the builder of the Great Pyramid wanted to have an astronomical observatory as well as a tomb. To begin with, I suppose Egyptologists are quite clear that a main purpose of each pyramid was that it should serve for a tomb. And I suppose, further, that this being so, it was essential that each pyramid, including that one which we have been regarding hitherto only in its astronomical aspect, should be as nearly as possible completed before the death of its future occupant. There may be, for aught I know, some reason to believe that in the days of the pyramids an Egyptian king might be able in some way to assure himself of the *bona fides* of his successors, and that they would continue the work which he had begun and more than half completed. But it is very difficult to imagine that this really was the case. Human nature must in those days have resembled pretty closely human nature in our own time; and it seems as unlikely that a king could trust in his successors so far as to believe they would expend large sums of money and a great amount of labor, in completing a work in which they had no direct or actual interest, as that, supposing he trusted them to this degree, their conduct after his death would have justified his confidence. Thus, when we find that the Great Pyramid was actually completed in the most careful and perfect manner, we have very strong reason for believing it to have been all but completed during the lifetime of the king, its builder—if it was indeed intended for his tomb. I must confess that the exclusively tombic theory of the Great Pyramid (at least) had always seemed to me utterly incredible, even before I advanced what seems to me the only reasonable interpretation of its erection. One may admit that the singular taste of the Egyptian kings for monstrous tombs was carried to a preposterous extent, but not to an extent quite so preposterous as the exclusively tombic theory would require. Of course, when we see that the details of the great edifice indicate unmistakably an astronomical object, which was regarded as of such importance as to justify the extremest care, our opinion is strengthened that the pyramid was not solely meant for a tomb. For this would bring in another absurdity, scarcely less than that involved in the exclusively tombic theory of structures so vast, if even they were non-astronomical—this, namely, that the Egyptian kings thought the celestial bodies and their movements so especially related to *them*, that their long home must be astronomically posited with a degree of care far surpassing that which has *ever** been given to an astronomical observatory. Common sense compels us to believe that whether the Great Pyramid was meant for a tomb or not, its astronomical character was given to it for some purpose relating to the living king who had it built. (I suppose Egyptologists are absolutely certain that the Great Pyramid *was* built by one king, and, therefore, within a few decades of years.)

Now, it is not reasonable to suppose King Cheops' purpose was simply scientific. We may fairly take it for granted that the king who expended such vast sums and sacrificed so many lives to build for himself a tomb, was not a man taking a disinterested interest in science, or even ready to help the priests of his day to regulate religious ceremonials by astronomical observations conducted with reference only to general religious relations. To put the matter plainly, the builder of the Great Pyramid must have thought of himself first; next, of his dynasty; then, perhaps, of the priesthood (though always with reference to the bearing of religious ceremonies on the welfare of himself and his dynasty); lastly, of his people, as part of his wealth and power. For abstract science he cared not, we may be well assured, a single jot. I do not wish to suggest that Cheops was wickedly selfish. I have no doubt he was thoroughly persuaded that he was carrying out the purpose of his existence in expending much treasure and many lives on his own well-being (both before and after death). But there can be no doubt this *was* the real object of his expenditure of time, and wealth, and human life on the great structure which bears his name.

Now, our thoughts are at once turned by these considerations to that one sole line along which astronomy ever has been followed with the hope of material profit; and we are led to remember that if there is one idea which has more strongly taken possession of the human race than any other, or one which more than any other is associated with the astronomy of ancient Egypt, it is the idea that the stars in their courses rule the fate of men and nations. When we remember that even now, when science has shown the utter incorrectness of the ideas that underlie the ancient system of astrology, this system has its influence over millions. Even now the terms belonging to the system remain part of our language. Our very religion has all its times and seasons regulated in ways derived from the astrological system of old Egypt. Our Sunday is the old Chaldean and Egyptian quarter-month rest day, and the Jewish Sabbath is this quarter-month rest day associated with the belief in the malefic influence of the planet (Saturn), which formerly ruled the last day of the week (still called Saturday or Saturn's-day). The morning and evening sacrifices of the Jews and their new moon festivals were manifestly astronomical in origin—in other words astrological (for astronomy was nothing except as astrology to the old Chaldeans and Egyptians). The Feast of the Passover, however later associated with other events, was derived from the old astrological observance of the passage of the sun (the Passing over of the Sun-God) across the equator, ascendingly: while the Feast of Tabernacles was in like manner ruled by the passage of the sun over the equator descendingly. Our calendar rules for Easter and other festivals would never, we may be well assured, have been made to depend on the moon, but for their original derivation from astronomical (that is astrological) ceremonial.†

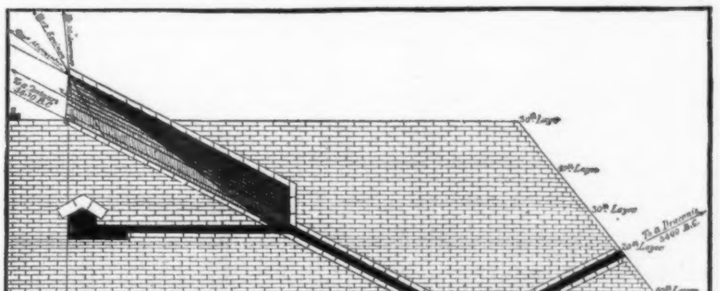


FIG. 2.—VERTICAL SECTION OF THE PYRAMID OBSERVATORY THROUGH THE PLANE OF THE PASSAGES AND GALLERY, SHOWING THE RANGE OF VIEW OF THE GREAT OBSERVING TUBE.

* Some may be disposed to reject a change which they may imagine displaces the Pleiades from the position which Professor Piazzi Smyth assigned to that interesting group at the date when he supposed the Pyramid was built. But there never was the least real significance in that position. If the mistaken idea entertained by many, and repeated by Flammarion, Haliburton, and others, that the Pleiades at their meridian shone down the Great Gallery at the very time when the Pole Star of 2170 B. C. shone down the descending Gallery, had been correct, there might have been some reason to be struck by the coincidence. But it should hardly be necessary to tell the reader what every astronomer knows, that the Pleiades never did or could shine down the Great Gallery, and in the year 2170 B. C. were thirty-eight degrees (!) north of that position.

* Even in our own time, though we get greater accuracy in our observations than Cheops obtained in his pyramid, we have not to give anything like the same degree of care to the work.

† The Jewish people, when they left Egypt after their long sojourn there, had doubtless become thoroughly accustomed to the religious observances of the Egyptians (at any rate there is not the slightest reference even to the Sabbath before the sojourn in Egypt), and were disposed not only to retain these observances, but to associate with them the Egyptian superstitions. We know this, in fact, from the Bible record. Moses could not—no man ever could—turn a nation from observances once become part of their very life, but he could, and did, deprive them of their superstitious character.

When we remember that the astronomy of the time of Cheops was essentially astrology, and astrology a most important part of religion, we begin to see how the erection of the mighty mass of masonry for astronomical purposes may be explained—or, rather, we see how, being certainly astronomical, it *must* be explained. Inasmuch as it is an astronomical building, erected in a time when astronomy was astrology, it was erected for astrological purposes. It was in this sense a sort of temple, erected, indeed, for the peculiar benefit of one man or of a single dynasty; but as he was a king in a time when being a king meant a great deal, what benefited him be doubtless regarded as a benefit also to his people; in whatever sense the Great Pyramid had a religious significance with regard to him, it had also a national religious significance.

It would have been worth Cheops' while to have this great astrological observatory erected, even if by means of it he could learn only what was to happen, the times and seasons which were likely to be fortunate or unfortunate for him or his race, and so forth. But in his day, as in ours, astrology claimed not only to read but also to rule the stars. Astrologers did not pretend that they could actually regulate the movements of the heavenly bodies, but they claimed that by careful observation and study they could show how the best advantage could be taken of the good dispositions of the stars, and their malefic influences best avoided. They not only claimed this, but doubtless many of them believed it; and it is quite certain that those who were not astronomers (*i. e.*, astrologers) were fully persuaded of the truth of the system which, even when the discovery of the true nature of the planets has entirely disproved it, retains still its hold upon the minds of the multitude.

There is, so far as I can see, no other theory of the Great Pyramid which even comes near to giving a common-sense interpretation of the combined astronomical and sepulchral character of this wonderful structure. If it is certain on the one hand that the building was built astronomically, and was meant for astronomical observation, it is equally certain that it was meant for a tomb, that it was closed in very soon after the king died for whom it was built, that, in fine, its astronomical value related to himself alone. As an astrological edifice, a gigantic horoscope for him and for him only, we can understand its purport, much though we may marvel at the vast expenditure of care, labor, and treasure at which it was erected. Granted full faith in astrology (and we know there was such faith), it was worth while to build even such a structure as the Great Pyramid; just as, granted the ideas of Egyptians about burial, we can understand the erection of so mighty a mass, and all save its special astronomical character. Of no other theory, I venture to say, than that which combines these two strange but most marked characteristics of the Egyptian mind, can this be said.—*Knowledge.*

RELATIVE POWER OF ANTISEPTICS.

The *Revue Scientifique* (February 4) contains an abstract of experiments made by M. Jalan de la Croix to ascertain the relative value of various substances in preventing the development or evolution of the microbia of putrefaction. He placed finely divided boiled or raw meat in water, and ascertained the maximum and minimum quantities of each substance that were effective. The figures in the following table indicate the number of grammes of water in which one gramme of the substance mentioned prevents the development of microbia:

Substance employed.	Maximum dose in which development is not arrested.	Minimum dose in which development is arrested.
Alcohol	30	1·77
Chloroform	134	1
Soda biborate	107	14
Eucalyptol	308	14
Phenol	1,002	10
Thymol	2,229	20
Potash permanganate	3,041	35
Picric acid	3,041	100
Borated soda salicylate	3,377	30
Benzoic acid	4,020	50
Ethereal oil of mustard	5,734	40
Sulphurous acid	7,534	72
Alum acetate	7,535	478
Salicylic acid	7,677	343
Mercury bichloride	8,358	2,525
Lime hypochlorite	13,092	109
Sulphuric acid	16,782	135
Iodine	20,020	410
Bromine	20,875	493
Chlorine	34,509	431

From which it will be seen that chlorine, the hypochlorites, and perchloride of mercury are very effective, while alcohol is comparatively impotent.

MEDICAL ELECTRICITY.

A paper "On Measurement in the Medical Application of Electricity," was read before the Society of Telegraph Engineers, by Dr. W. H. Stone and Dr. Walter Kilner, on March 9. Dr. Stone commenced by stating that the subject had been suggested by Lieutenant-Colonel Webber, the chairman, and that the details the authors proposed to give that evening were mainly preliminary to fuller treatment, which they hoped to offer at some future period.

Medical electricity, he said, had been up to now a heterogeneous mixture of loose statements, doubtful diagnosis, and erroneous therapeutics. Glaring instances of these were given. With hysteria, metallotherapy, and magnetic appliances, they did not propose to deal; science is in far too elementary a state to see through these obscure, though real phenomena. Probably, the key to the great enigma of the connection between electricity and nerve force had yet to be found. The bold statement that "electricity is life" is demonstrably false in many particulars. Speaking generally, medical electricity had suffered from its exclusive handling by physiologists and physicians, who might receive valuable help from physicists; indeed, the writers of the paper were actually soliciting such assistance at the hands of this young and active society. Medicine and its kindred arts lend themselves ill to measurement; the tone of mind required for their practice is rather judicial than computative; it is oftener concerned with weighing evidence, and balancing alternatives, than with solving equations. But men who work by measurement are usually sterling and accurate men; indeed, Prof. Schuster has recently shown how mathematics can help science. Where measurement *can* be used, it *should* be used, and this was their text for the evening.

The speaker then proceeded to divide the forms in which electricity had been used medically into four, namely: (1) continuous currents, (2) continuous currents made to intermit, (3) induced currents, termed generally "Faradization," (4) statical electricity. The last of these was the first employed, but it had given the least satisfactory results of any. The third method had been far the most deeply studied. Duchenne's great work on Localized Electrization early drew attention to this department. That genuine and indefatigable observer was able to point out so many definite diagnoses, and to isolate so many new nervous and muscular diseases by means of the induction-coil, that this instrument had been given somewhat excessive prominence as a therapeutic agent. Physiologists had also found in it a convenient stimulant for testing the action of nerves and the irritability of muscle; perhaps also the localization of brain functions. Hence muscular contraction and the action of intermittent currents in alternate directions had been too much relied on as evidence of activity. One chief object of the paper was to point out that the future of electro-therapeutics lies more in the continuous current, used either in its first or second form, the latter of which has hitherto received little or no attention. In confirmation of these views, extracts were read from Prof. Erb's valuable memoirs in Ziemssen's Cyclopædia of Medicine.

Before, however, a single step could be taken in this scientific path, we must have some tolerably accurate mode of measuring the agent we are employing. It is obvious that the units used should be as far as possible those generally adopted in the scientific world.

To begin with resistance: This in the human body is singularly great, and is especially located in the epidermis, which, when dry, is an excellent insulator. Wetting it with sulphate of zinc or common salt diminishes this resistance very materially; though even when care is taken in this respect, the residual opposition to a current is large. From hand to hand it is usually about 6,000 ohms. In the larger bulk of the trunk, from the sacrum to the nape of the neck, it never, even after long wetting, sinks much under 1,500 ohms. That of the head, from nape to forehead, is about 2,000 ohms. In one case it was more precisely 1,930 ohms, in an adult, and in another, a child, 2,500 ohms. The resistance of different tissues, though not exactly to the present purpose, had been studied by Prof. Eckhard, who stated that muscle was the best conductor, and that this being taken as a unit, cartilage would have a resistance twice, tendons and nerves about 2·1, and bone nineteen times as great. Matteuci states that muscles conduct four times as well as nerves, brain, or spinal cord. The resistance of the skin varies from day to day, being modified by moisture, and by the fullness of the capillary vessels. In a particular case, the positive pole of a battery was placed on the sacrum of a child, and the other on the leg, over the extensors of the foot. By using the same current, and adding quickly a known resistance, the resistance of the body was at first found to be 11,250 ohms, which, on thoroughly soaking the skin, was reduced 2,875 ohms. Three days previously, the resistance before soaking was 13,000 ohms, and after that process sank to 3,000 ohms. Personal idiosyncracy exercises an influence, a delicate skin conducting better than one which is coarse. The face and neck offer the least; the soles and palms the greatest resistance. Disease causes variation of conductivity; the skin over affected muscles in lead paralysis has its resistance increased, while in many old cases of hemiplegia it is decreased to a greater or less extent according to the amount of atrophy which has taken place.

The resistance of muscle in disease is sometimes diminished, sometimes augmented. Augmentation takes place at the commencement of degenerative changes, from the inferior conductive power of fat to that of healthy muscle. In a case of infantile paralysis, the sound leg had a resistance of 2,500 ohms, the affected leg of 3,250 ohms. In a wasted muscle of many years' standing, the enormous resistance of 16,500 ohms was reached. It was both easy and desirable to multiply facts such as these.

The second preliminary point was the current which could be borne with impunity. Here results were very discordant. In the three fatal cases from touching the conductors of dynamo-machines, at a music-hall, in the Russian Navy, and at Hatfield, the necessary facts for measurement were absent; although Dr. Siemens had stated that he had often taken a current sufficient to produce a powerful light with impunity. In a case now in St. Thomas's Hospital, a current of 50 milliwebers was borne with difficulty, and one of 20 milliwebers with ease and great benefit. A case of diabetes, recorded by Dr. Stone in the Proceedings of the British Association at York in 1881, took about 10,000 micro-ampères, or 10 milliwebers, through his head, from nape to forehead, after some practice; using for its production from 15 to 20 cells of a bichromate battery. The particular battery, however, mattered very little. Leclanché's, bichromates, and zinc-carbons, with sulphate of mercury, all act well, and need not be of large size or small resistance. One was shown, in which test-tubes filled with mercuric sulphate, containing free acid, formed the jars; another in which a rod of zinc of 5-16 in. diameter, and a similar sized carbon, such as is used in electric lamps, were immersed in the bichromate solution. Connection was here made with the carbon by a piece of drawn tube sprung on to it, thus doing away with the use of clamps. All these, as well as most of the apparatus shown, were made in Dr. Stone's workshop, chiefly with his own hands.

In consequence of the high resistance of the skin, it was essential to give a large size to the poles employed for applying the current, etc. Amalgamated zinc, with the mixture of potter's clay kneaded with the solution of common salt, used in physiological experiments, laid over it, was perhaps, theoretically, the best; but powdered carbon, placed in a bag and immersed in salt and water, answered equally well; or the surgical appliance termed Spongio-piline, a thick felt, backed by India-rubber, through which a well-tinned copper wire was threaded, so as to encompass its whole circumference without anywhere projecting so as to touch the cuticle. The poles could hardly be too large.

A convenient form of Thomson galvanometer with graduated shunts, due to Dr. Kilner, was shown, and also a simple but effective instrument for producing intermissions in the current at any required interval of time. This apparatus consisted of a metronome with contact-pieces dipping into mercury-cups at each oscillation, a condenser being placed under the instrument to get rid of the extra current, and so to equalize the physiological effect of the making and breaking currents.

The measurement of induced currents presented considerable difficulties. The Conference at Paris had recommended the uses of standard induction-coils, but this method does not give any but arbitrary measures. Dr. Stone had tried and showed a vacuum-tube, in which the tension of air could be varied by combining it with a barometric column and a movable cistern. This gave a ready means of varying the force of the discharge, by using it as a shunt of variable resistance, and had the interesting results of shunting the "make-current" at a definite point, while allowing the "break-current," which is about six times stronger, to pass between the platinum points; thus obtaining an induced current in one direction only. Latterly he had adopted also condensers of definite capacity charged to definite potentials. The writers were, however, still experimenting with another method, depending on Sir W. Thomson's determinations of spark-length. The most practical method, at present, seemed to be to pass a continuous current of measured strength through an automatic commutator, which at alternate oscillations diverted it in one and the other direction. If there was any real physiological value in rapid reversals of direction, as was claimed by some experimenters, it could thus be secured, without the use of an induction coil. Another form of rotating-commutator was also shown, in which an ebonite cylinder, pressed on by six springs, at each quarter-turn connected, first, the condenser to the battery, so as to charge it, and then discharged it through the patient. To obivate the necessity of employing a large battery with the condenser arrangements, Planté's secondary battery could be charged in parallel position from a small number of Grove's cells, and discharged through the condenser in series. In all these contrivances, however, as the current gained in tension, it seemed to lose somewhat in chemical and catalytic power, and to assimilate gradually to the static form.

In the discussion which followed Mr. Preece pointed out that the use of electricity for curative purposes had been advocated as long ago as the year 1759, by John Wesley, and recommended the use of the dynamometer for the measurement of induced currents, as this instrument gave indications in the same direction with all currents. Prof. McLeod, Mr. Fitzgerald, and Prof. Ayrton also made comments on the paper.

A catalogue containing brief notices of many important scientific papers heretofore published in the Supplement, may be had gratis at this office.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of The Supplement, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of The Supplement can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50, stitched in paper, or $3.50, bound in stiff covers.

Combined Rates.—One copy of Scientific American and one copy of Scientific American Supplement, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,
261 Broadway, New York, N. Y.

TABLE OF CONTENTS.